Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

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Course Structure and Contents

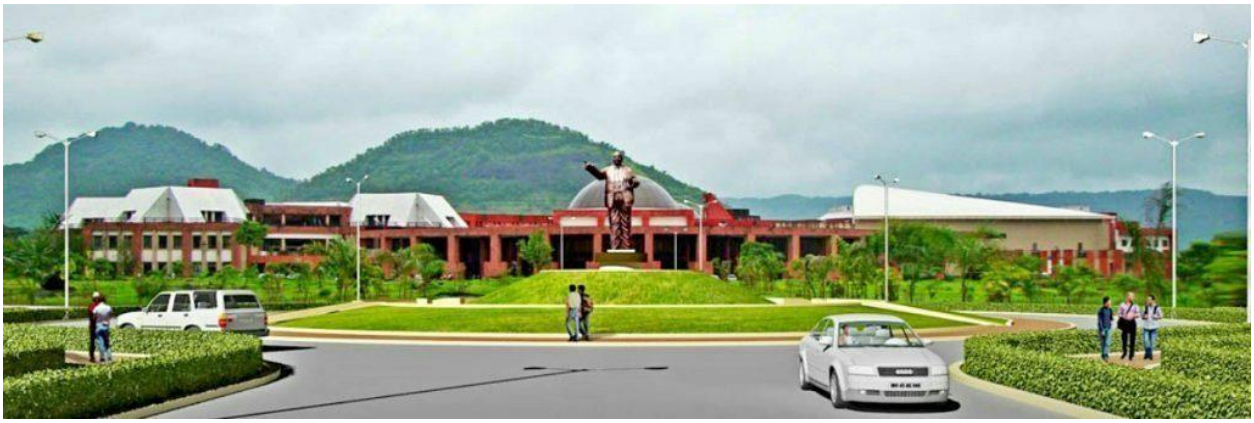
for

M.Tech. in Thermal and Fluid Engineering/Thermal Engineering/ Heat and Power

(For Affiliated Institutes Only)

Syllabus as per the guidelines of National Education Policy 2020

To be implemented from Academic Year 2024-25.



Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need based research and extension activities.

Program Educational Objectives (PEOs)

PEO1: To train student's within depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of t her ma l and fluids engineering.

PEO2: To enable post graduates to carry out innovative and independent research work,

disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.

PEO3: To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.

PEO4: To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning ability for their successful professional career

Program Specific Outcome:

1. Students will design and optimize thermal and fluid systems using thermodynamics and fluid mechanics principles, creating sustainable and energy-efficient solutions for modern engineering challenges.
2. Graduates will expertly use advanced simulation tools to model and solve complex thermal and fluid engineering problems, leading to optimized designs in various industries.

Program Outcomes (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering Fundamentals and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Abbreviations

PEO : Program Educational Objectives

PO : Program Outcomes

CO : Course Outcomes

L : No. of Lecture hours (per week)

T : No. of Tutorial hours (per week)

P : No. of Practical hours (per week)

C : Total number of credits

PCC : Professional Core Course

OEC : Open Elective Course

PEC : Professional Elective Course

AC : Audit Course

AEC : Ability Enhancement Course

VEC : Vocational Education Course

IKS : Indian Knowledge Society

MDM : Multidisciplinary Minor

Semester-I

Level	Course Code	Type of Course	Course Name	L	T	P	Credit	Th	CA/MSE	PR/OR	Total
6.5	Program Core Course (Theory)										
		PCC	Advanced Thermodynamics	3	1		4	60	20/20		100
		PCC	Advanced Heat Transfer	3	1		4	60	20/20		100
		PCC	Instrumentations and Measurement in Thermal Systems	3			3	60	20/20		100
		PCC	Measurement in Thermal Systems Lab			2	1		20/20	60	100
	Program Elective Course (Theory)										
		PEC-I	A. Design of Renewable Energy System B. Advanced I.C. Engine and Electric Vehicle C. Design of Air conditioning systems D. Computational Fluid Dynamics	3			3	60	20/20		100
		PEC-II	A. Energy Conservation and Management B. Steam Engineering C. Pumps, Blowers and Compressors D. Battery Thermal Management System	3			3	60	20/20		100
		OEC	Research Methodology and IPR	3			3	60	20/20		100
		AC	A. Universal Human Values (UHV) & Professional Ethics B. Plastic Waste Management C. YOGA for Stress Management D. Value Education **(No Credit)**	2					25/25		50
			Total	**20**	**2**	**2**	**21**				**750**

Semester-II

Level	Course Code	Type of Course	Course Name	L	T	P	Credit	Th	CA/MSE	PR/OR	Total
6.5	Program Core Course (Theory)										
		PCC	Advanced Fluid Mechanics	3	1		4	60	20/20		100
		PCC	Numerical Methods and Computational Techniques	3	1		4	60	20/20		100
	Program Core Course (Lab)										
		PCC	Mini Project			2	1		20/20	60	100
		PCC	Seminar			2	1		20/20	60	100
		AEC/VEC/ IKS	A. Indian Knowledge System: Concepts &Applications in Engineering B. Indian Knowledge System: Humanities & Social Sciences C. Ancient Indian Management	2			2		25/25		50
	Program Elective Course (Theory)										
		PEC-III	A. Conservation of Energy in Buildings B. Cryogenic Engineering C. Advanced Optimization Techniques D. Design of Thermal System	3			3	60	40		100
		PEC-IV	A. Nanotechnology B. Thermal Energy Storage C. Steam and Gas Turbine D. Advanced Refrigeration	3			3	60	40		100
	Open Elective Course (Theory)										
		OEC-I	A. Machine Learning and Applications B. Industrial Product Design C. Control Techniques in Electrical Drives D. Solid Waste Management	3			3	60	40		100
			Total	**17**	**2**	**4**	**21**				**750**

Semester-III

Level	Course Code	Type of Course	Course Name	L	T	P	Credit	Th	CA/MSE	PR/OR	Total
7.0	Program Core Course (Project)										
		PCC	Dissertation Phase-I				10		50	50	100
		OEC II	A. Project Management B. Mechatronics and Embedded System C. Environmental Engineering	3			3	60	20/20		100
		PC	Intellectual Property Rights	3			3	60	20/20		100
		MDM	A. Applications of IoT B. e-Commerce Technologies c. Entrepreneurship & Start-ups	3			3	60	20/20		100
						Total Credit	**19**			**Total Mark**	**400**

Semester IV

Level	Course Code	Type of Course	Course Name	L	T	P	Credit	Th	CA/MSE	PR/OR	Total
7.0	Program Core Course (Project)										
		PCC	Dissertation Phase-II				20		100	100	200
						Total Credit	**20**		**Total Mark**		**200**

Semester-I

Advanced Thermodynamics

	Advanced Thermodynamics	PCC	3-1-0	4 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Objectives: Objectives of this course are

1. To understand the entropy and exergy balance of thermodynamic systems
2. To get familiar with the use of property tables and charts of pure substances
3. To acquaint with various thermodynamic property relations and their applications
4. To get familiar with composition of gas mixtures and chemical equilibrium of gas mixture
5. To predict intermolecular potential and excess property behaviour of multi-component systems.

Course Outcomes: At the end of the course, students will be able to

CO1	Apply entropy and exergy balance to thermodynamic systems.
CO2	Utilize property tables and charts of pure substances
CO3	Determine various non-measurable properties by using thermodynamic property relations
CO4	To get familiar with composition of gas mixtures and chemical equilibrium of gas mixture
CO5	Predict intermolecular potential and excess property behavior of multi-component systems.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1		2	1		1						
CO3	2	1		1		1						
CO4	1	1										
CO5	1			1								

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1 [6 Hrs]

Introduction of Entropy and Exergy:

Entropy and Entropy relation, increase of entropy principle, Entropy transfer with heat and mass, Entropy balance of closed system and control volume.

Exergy: concept of availability/exergy, Exergy of energy and transfers. Reversible work and Irreversibility, Exergy change of closed system and control volume, Decrease of Exergy principle, Exergy balance of closed system and control volume, Exergy destroyed, Second law efficiency of steady flow devices, Numerical on second law of thermodynamics.

Unit 2 [6 Hrs]

Properties of Pure Substances:

Phase change process of pure substances, P-v-T surface, Use of property tables and charts. Gibb's phase rule Ideal gas equation of state, Deviation from ideal gas behaviour, compressibility factor, Law of corresponding states, generalized compressibility chart, other equations of state, Vander walls, Berthelot, Dieterici, Redlich-kwong equations, Bose-Einstein statistic. Fermi- Dirac statistics

Unit 3 [6 Hrs]

Thermodynamic Property Relations:

Partial Differentials and related rules, Helmholtz and Gibbs functions, The Maxwell relations, general relations for du, dh, ds, and Cv and Cp, Clapeyron equation, Clausius- Clapeyron equation, Joule Thomson Coefficient, Δh, Δu, Δs of real gases.

Unit 4 [6 Hrs]

Gas mixture:

Composition of a gas mixture, Mass fraction, Mole fraction, PVT behaviour of a gas mixture: Ideal and real gases, properties of a gas mixture: Ideal and real gases. equilibrium constant for ideal gas mixtures, chemical equilibrium for simultaneous reaction, variation of equilibrium constant with temperature.

Unit 5 [6 Hrs]

Irreversible thermodynamics: Reversible and irreversible process, the flux postulate, entropy production; heat flux, thermoelectric phenomenon; thermodynamic analysis of the thermocouple, Onseger's reciprocal relation.

Text Books:

1. Y. Cengel, M.A. Boles, and M. Kanoglu: Thermodynamics – An Engineering Approach, McGraw Hill, 9th edition, 2019.
2. P. K. Nag, Engineering Thermodynamics, McGraw Hill, 6th Edition, 2017.
3. R. Balmer, Modern Engineering Thermodynamics, Academic Press, Elsevier, 2011.
4. D. Winterbone and A. Turan, Advanced Thermodynamics for Engineers, Butterworth- Heinemann, Elseveir, 2nd edition, 2015.

Reference Books:

1. K. Wark, Advanced Thermodynamics for Engineers, McGraw Hill, 1994.
2. M. Moran, H. Shapiro, D. Boettner, and M. Bailey, Fundamentals of Engineering Thermodynamics, Wiley, 9th edition, 2018.
3. C. Borgnakke, and R. Sonntag, Fundamentals of Thermodynamics, Wiley, 10t edition, 2019.
4. M. Achuthan, Engineering Thermodynamics, PHI Learning Pvt. Ltd, 2nd edition, 2009.

Advanced Heat Transfer

	Advanced Heat Transfer	PCC	3-1-0	4 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the technical understanding the concepts of heat transfer in the background of real engineering problems
2. To familiarize the students about the importance of heat transfer process apply to industrial applications
3. To understand the heat transfer concepts, apply to other domain of thermal engineering in general

Course Outcome:-

After successful completion of the course, students will be able to,

CO1	Analyze heat conduction
CO2	Develop a solution to heat convection to external laminar flow
CO3	Formulate heat convection to internal laminar flow.
CO4	Interpret convection with phase change
CO5	Analyze heat radiation

Mapping of COs with Pos

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	1			1		1						
CO3	1	1	2									
CO4	1											
CO5	1			1								

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1 [6 Hrs]

Heat Conduction:

Governing equations, steady and transient heat conduction, heat conduction with heat generation general boundary condition and initial condition for heat equation, unsteady one-dimensional conduction, Numerical methods used for two and three dimensional steady and unsteady state conduction discretization of two and three-dimensional equation.

Unit 2 [6 Hrs]

Boundary Layer Flow Application to External Flow:

Derivation of governing equations of momentum, energy and species transport, Order of magnitude analysis The boundary layer concept simplification of the governing equation, Similarity solution techniques, Blasius and Pohlhausen's solutions.

Boundary Layer Flow Application to Internal Flow:

Concept of developing and fully developed flows. Thermally developing flows: Concept of thermally fully developed flow and its consequences inner constant wall flux and constant wall temperature conditions. Heat flow in

Unit 3 [6 Hrs]

Convection in External and Internal Turbulent Flow:

Introduction, Eddies and vo1ticity, conservation equation of turbulent flow, Analysis of external turbulent flow. Eddy diffusivity and Prandtl's Mixing length theory, Reynolds analogy. Numerical on implicit and explicit approach,

Unit 4 [6 Hrs]

Convection with Phase Change:

Condensation with change of phase, laminar and turbulent film on vertical surface, Nusselt film condensation theory, drop condensation, Pool boiling regimes, nucleate boiling and peak heat flux.

Unit 5 [6 Hrs]

Radiation heat transfer

Radiation, shape factor, analogy, shields, radiation of gases & vapors

Text Books:

1. T. L. Bergman, A. S. Lavine, F. P. Incropera, D. P. DeWitt, Fundamentals of Heat and Mass Transfer,Wiley, 2011.
2. Y. Cengel, A. Ghajar, Heat and Mass Transfer, Tata Mc Graw Hill, 2011.
3. M.N. Ozisik, Heat transfer - A Basic approach, Mc Graw Hill Int., 1985.
4. Convective Heat transfer, A Bejan, John Wiley and sons, 2013.

Reference Books:

1. J.P. Holman, Heat Transfer, Mc Graw Hill, 2002.
2. S.P. Sukhatme, Heat transfer, University Press, 2005.
3. J. Welty, G. L. Rorrer, D. Foster, Fundamentals of Momentum, Heat and Mass Transfer Wiley, 2014

Instrumentations and Measurement in Thermal Systems

	Instrumentations and Measurement in Thermal Systems	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

To impart knowledge on the following Topics -

1. Basic functional elements of instrumentation
2. Fundamentals of electrical and electronic instruments
3. Comparison between various measurement techniques
4. Various storage and display devices
5. Various transducers and the data acquisition systems

Course Outcomes::

At the end of the course, student should be able to:

CO1	Analyse different measuring parameters of any electronics/mechatronics system
CO2	Design and evaluate characteristics of different types of mechatronics/ electrical/ electronic system
CO3	Understand different types of wave/spectrum analyser.
CO4	Interface various system components and analyse its data using data acquisition system.
CO5	Understand Analog Indicating Instruments

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Basics of Measurements: [6 Hrs]

Accuracy, Precision, resolution, reliability, repeatability, validity,

Errors and their analysis, Standards of measurement. Bridge Measurement: DC bridges Wheatstone bridge, AC bridges – Kelvin, Hay, Maxwell, Schering and Wien bridges, Wagner ground Connection. Electronic Instruments for Measuring Basic Parameters: Amplified DC meter, AC Voltmeter, True- RMS responding Voltmeter, Electronic multi-meter, Digital

Unit 2

Oscilloscopes: [6 Hrs]

Cathode Ray Tube, Vertical and Horizontal Deflection Systems, Delay lines, Probes and Transducers, Specification of an Oscilloscope. Oscilloscope measurement Techniques, Special Oscilloscopes Storage Oscilloscope, Sampling Oscilloscope. Signal Generators: Sine wave generator, Frequency Synthesized Signal Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators.

Unit 3

Signal Analysis: [6 Hrs]

Wave Analyzer, Spectrum Analyzer. Frequency Counters: Simple Frequency Counter; Measurement errors; extending frequency range of counters Transducers: Types, Strain Gages, Displacement Transducers

Unit 4

Digital Data Acquisition System: [6 Hrs]

Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer- Controlled Test Systems.IEEE-488 GPIB Bus

Unit 5

Analog Indicating Instruments[6 Hrs]

DC galvanometer, PMMC and Moving Iron instruments, Voltmeter, Ammeter, RMS and True RMS concept, Extension of range of ammeter, design of multirange ammeter, extension of range of voltmeter, design of multirange voltmeter, series and shunt type ohmmeter, Single phase wattmeter: construction and working

Text Books:

1. Modern Electronics Instrumentation & Measurement Techniques, by Albert D.Helstrick and William D.Cooper,
Pearson Education. Selected portion from Ch.1, 5-13.
2. Elements of Electronics Instrumentation and Measurement-3rd Edition by Joshph J.Carr.Pearson Education.
Selected portion from Ch.1,2,4,7,8,9,13,14,18,23 and 25.

Reference Books:

1. Electronics Instruments and Instrumentation Technology – Anand, PHI
2. Doebelin, E.O., Measurement systems, McGraw Hill, Fourth edition, Singapore, 1990.

Measurement in Thermal Systems Lab

	Seminar	PCC	0-0-2	1 Credits
Exam Scheme				

CA 20 Mark	CA 20 Marks	PR/OR 60 Marks	Total 100 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Contents Experiments on the following set-ups (Any Six):

Part A (At least 3 experiments are mandatory)

This course aims to:

To understand the working principle of various transducers and their application in engineering

1. Measurement of strain and load using strain gauges.
2. Determination of characteristics of te6mperature sensor (AD590).
3. Determination of the characteristics of thermocouple.
4. Determination of the characteristics of RTD

Part B (At least 3 experiments are mandatory)

Experiments (1-4) shall be done using python/Labview-Aurdino interface

1. Measurement of temperature
2. Measurement of level in water tank
3. Measurement of pressure

4. Wind velocity measurement
5. Measurement of humidity

Design of Renewable Energy system

	Design of Renewable Energy system	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	the limitations of renewable energy system
CO2	Will be able to explain solar thermal system and solar electric system
CO3	Introduction of Wind Energy
CO4	Will Able To Understand Energy From Ocean
CO5	Biomass energy with emerging technology

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1 [6 Hrs]

Introduction to Renewable Energy -

Economy Energy and Sustainable development-Kyoto Protocol -Classification of Energy Resources; Conventional Energy Resources -Availability and their limitations; Non-Conventional Energy Resources –Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario

Unit 2 [6 Hrs]

Solar Energy:

Introduction, Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data(Numerical Problems)–Pyranometer and Pyrheliometer -Solar Thermal Collectors –General description and

characteristics –Flat plate collectors –Heat transfer processes –Solar concentrators(Parabolic trough, Parabolic dish, Central TowerCollector)
Solar Photovoltaic Solar Cell fundamentals, characteristics, classification, construction of Module.

Unit 3 [6 Hrs]
Wind Energy
Introduction–Wind Turbine Types (HAWT and VAWT) and their construction- Wind power curve-Betz's Law-Power from a wind turbine(Numerical Problems)-Wind energy conversion system(WECS) – Fixed–speed drive scheme-Variable speed drive scheme.-Effect of wind speed and grid condition(system integration).

Unit 4 [6 Hrs]
Ocean Energy
Tidal Energy –Principle of Tidal Power, Components of Tidal Power Plant (TPP), Classification of Tidal Power Plants, Advantages and Limitations of TPP. Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation –Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC); Site-selection criteria, Biofouling, Advantages & Limitations of OTEC.

Unit 5 [6 Hrs]
Biomass Energy:
Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, factors affecting biogas generation, types of biogas plants –KVIC and Janata model;. EMERGING TECHNOLOGIES: Fuel Cell, Hydrogen Energy, alcohol energy and power from satellite stations.

References:
1. A.A.M. Saigh(Ed): Solar Energy Engineering, Academic Press, 1977
2. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001.
3. Thomas E. Kissell, David M. Buchla, Thomas L. Floyd, Renewable energy systems ,Pearson 2017
4. Boyle G. (ed.), Renewable Energy -Power for Sustainable Future, Oxford University Press, 1996
5. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011.
6. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
7. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
8. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994
9. Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams, Renewable Energy –Sources for Fuel and Electricity, Earth scan Publications, London, 1993.
10. Khan B. H., Non-Conventional Energy Resources, Tata McGraw Hill, 2009.

Advanced I.C. Engine and Electric Vehicle

	Advanced I.C. Engines & Electric Vehicle	PEC	3-0-0	3 Credits

Exam Scheme			
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of IC engines
2. To familiarize the students about the IC engines systems, processes, alternative fules etc
3. To understand the environment aspects of IC engines

Course Outcomes:

CO1	To familiarize the students with latest developments in Advanced I.C. Engines to cope up with requirements of industry.
CO2	To familiarize the students with developments in Advanced I.C. Engines
CO3	To provide a technical understanding of common engineering processes related with Advanced I.C. Engines
CO4	Identify the use of pollution control and fuel economy components
CO5	Understand Modern trends coming in IC Engine technology.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Contents

Unit 1

Spark Ignition Engines [6 Hrs]

Air-fuel ratio requirements, Design of carburetor –fuel jet size and venturi size, Stages of Combustion-normal and abnormal combustion, Factors affecting knock, Combustion chambers, Introduction to thermodynamic analysis of SI Engine combustion process

Unit 2

Compression Ignition Engines [6 Hrs]

Stages of combustion-normal and abnormal combustion – Factors affecting knock, Direct and Indirect injection systems, Combustion chambers, Turbocharging, Introduction to Thermodynamic Analysis of CI Engine Combustion process

Unit 3

Engine Exhaust Emission Control [6 Hrs]

Formation of NO_X, HC/CO mechanism, Smoke and Particulate emissions, Green House Effect, Methods of controlling emissions, Three way catalytic converter and Particulate Trap, Emission (HC, CO, NO and NOx) measuring equipments, Smoke and articulate measurement, Indian Driving Cycles and emission norms like Bharat Stage norms BS VI

Unit 4

Electrical and Hybrid Vehicles: [6 Hrs]

Types of hybrid systems, Objective and Advantages of hybrid systems. Current status, Future developments and Prospects of Hybrid Vehicles Integrated Starter Alternator: Starts stop operation, Power Assist, Regenerative Braking. Advanced lead acid batteries, Alkaline batteries, Lithium batteries. Development of new energy storage systems. Deep discharge and rapid charging ultra-capacitors.

Unit 5

Design for EV applications: [6 Hrs]

Designing battery type & capacity for electric vehicle applications – namely Electric 2 & 3 wheelers.
Basic Knowledge on Batteries in important Applications:
Stationary or Standby power- Power stations/ sub-stations/ Solar & wind Power/ Process Industries/ Data Centers/ Telecom/ UPS/ Inverters

Text Books

1. John B Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill

2. Patterson D.J. and Henein N.A., "Emissions from combustion engines and their control", Ann Arbor Science publishers Inc, USA

3. Gupta H.N, "Fundamentals of Internal Combustion Engines", Prentice Hall of India

Reference Books

1. Ultrich Adler, "Automotive Electric / Electronic Systems", Robert Bosh GmbH

2. V. Ganeshan, " Internal Combustion Engines", Tata McGraw-Hill

3. C.F.Taylor, The internal combustion engines theory and practice, vol. I & II, MIT press

4. Thomas P J Crompton, Battery Reference Book, Elsevier, 2000.
5. Joey Jung, Lei Zhang , Jiujun Zhang 'Lead-Acid Battery Technologies: Fundamentals, Materials, and Applications' CRC Press , 1st edition, June 2015.
6. J. Li, S. Zhou, Yehui Han, Advances in Battery Manufacturing, Service, and Management Systems, John Wiley & Sons, 2016.

Design of Air Conditioning System

	Design of Air-Conditioning System	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test	Continuous Assessment	End-Sem Exam		Total

20 Marks	20 Marks	60 Marks	100 Marks

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of air conditioning
2. To familiarize the students about the air conditioning system design and its applications in real life situations
3. To learn the duct design and load calculation

Course Outcomes:

At the end of the course, student should be able to:

CO1	Demonstrate Air-conditioning processes and psychometric
CO2	Illustrate Ventilation, Necessity, Natural Ventilation, wind effect, Measurement of thermal comfort indices.
CO3	Formulate and solve problems of cooling, heating load calculations.
CO4	Design Air distribution, duct design for suitable problem
CO5	Analyze Sound propagation, SPL, PWL, Sound Intensity, room acoustics and apply noise control techniques

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	1											
CO3		2		2								
CO4		1			1	1						
CO5				1								

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Unit 1

Refrigeration Systems: [6 Hrs]

etry, Air-conditioning processes, Advanced psychrometry, ERSHF, winter airconditioning, Preparation of psychrometric charts.

Advanced Refrigerants:

Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal/ ~yoto Protocols-Eco Friendly Refrigerants.

Unit 2

Ventilation, Necessity, Natural Ventilation, wind effect, stack effect, flow around building, Thermal Comfort, Thermal human model, Measurement of thermal comfort indices

Unit 3

Solar geometry, Building Heat Transfer, Cooling Load Calculation, CLTD Method Cooling Load and Heat Loss calculations, Concept of energy days, Heating load calculation.

Unit 4

Room Air Diffusion, Filtration, Duct Design for real life applications such as hospitals , hotels, shopping malls etc., Air Distribution Design

Unit 5

Noise control, Sound propagation, SPL, PWL, Sound Intensity, room acoustics, sound control in ducts.

HVAC Equipment, Packaged and Split HVAC Equipment, Heat pump Design and selection, Equipment Selection, Auxiliaries

Text Books :

1. Handbook of Air Conditioning System Design, Carrier Air Conditioning Co., 1965.
2. ASHRAE Handbooks and ISHRAE Handbooks
3. Thermal Environmental Engineering, James L.Threlkeld, Prentice Hall,
4. Air conditioning engineering, W. P. Jones, ELBS
5. Refrigeration and Air-conditioning, Stoecker and Jones, McGraw Hill
6. Edward Pita, Air Conditioning Principles and Systems,Prentice Hall

Computational Fluid Dynamics

	Computational Fluid Dynamics	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Objectives:

1. Students will be able to understand the basics of conservation laws and transport mechanisms of fluid dynamics and numerical methods used for obtaining solution and calculation of engineering-parameters in CFD.
2. Algebraic formulation: develop the ability to do discretization by finite volume method.
3. CFD development: develop programming skills by in-house code development for conduction, convection or fluid dynamics problems.
4. CFD application and analysis: Learn to apply the code on various problems in fluid dynamics and heat transfer; and analyse as well as discuss the results.

Course Outcomes:

CO1	Apply suitable discretization technique to governing equations and convert into algebraic equations

CO2	Analyze the problem in fluid mechanics and heat transfer and mathematically model it
CO3	Develop an algorithm to solve the governing equations in CFD.
CO4	Create geometric model for real life application in an engineering domain.
CO5	Able to solve the numerical based on Navier stokes.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1 Introduction [6 Hrs]

Introduction to CFD: What is CFD?, Why to study CFD?, CFD analysis process: development, application and analysis. Essentials of Fluid-Mechanics and Heat-Transfer: Conservation and subsidiary laws, transport mechanisms, and differential formulation from the conservation laws, Brief introduction of ODE (IVP and BVP) and PDE, classification of PDE.

Unit 2 Essentials of Numerical Methods [6 Hrs]

Finite Difference Method (FDM), FDM based algebraic-formulation for 1D and 2D steady state heat conduction, iterative solution of system of linear algebraic equations, Initial and Boundary conditions, various methods to solve PDE numerically along with their advantages and disadvantages.

Unit 3 Discretization Techniques: Finite Volume Method [6 Hrs]

Discretization Methods, Discretization procedure in Finite-volume framework. Approximation of Surface Integrals, Approximation of Volume Integrals, explicit based solution-methodology for 1D system, upwind schemes.

Unit 4 Computational Heat-Transfer on a Cartesian-Geometry [6 Hrs]

Applications of Finite Volume Methods: One-dimensional and two-dimensional steady and unsteady state diffusion equation, steady state one-dimensional convection and diffusion, stability analysis, explicit and implicit method based solution-methodology.

Unit 5 Numerical Solution to Navier – Stokes Equation [6 Hrs]

Finite Volume Method (FVM) based algebraic-formulation for convection-diffusion problems, assessment of the central differencing scheme. Pressure correction technique, staggered grids, SIMPLE algorithm.

Text Books:

1. J. D. Anderson, Computational Fluid Dynamics, McGraw Hill, 1995
2. A. Sharma, Introduction to Computational Fluid Dynamics, Athena Academic and John Wiley & Sons, UK, 2017.
3. A. W. Date Introduction to Computational Fluid Dynamics, Cambridge Univ. Press, USA, 2009.
4. Versteeg, H.K. and Malalasekera W. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical, Harlow, 1995.
5. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2010.
6. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, New York, 1980.
7. K. Muralidhar, and T. Sundarajan, (Editors) Computational Fluid Flow and Heat Transfer (2nd ed.), IIT
Kanpur Series, Narosa Publishing House, New Delhi, 2003.
8. J.H. Ferziger, and M. Peric Computational Methods for Fluid Dynamics, Springer Verlag, Berlin, 2002.

Reference Books:

1. D.C. Wilcox, Turbulence modeling for CFD, DCW Industries, La Canada, CA, 3rd Ed., 2006.
2. C. Hirsch, Numerical Computation of Internal and External Flows - The Fundamentals of Computational
Fluid Dynamics, Butterworth-Heinemann, 2007
3. G. Biswas and V. Eswaran, Turbulent Flows: Fundamentals, Experiments and Modeling, Narosa Publishing House, 2002.

Energy Conservation and Management

	Energy Conservation and Management	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of Energy Conservation and management
2. To familiarize the students about the Energy audit and its applications in real life situations
3. To carry out a energy audit on the existed thermal system

Course Outcomes:

At the end of the course, student should be able to:

CO1	Demonstrate energy management principles, identify need, organizing it. carry out energy auditing.
CO2	Conduct economic analysis of any industry or power plant, obtain conclusion and suggest it to industry.
CO3	Interpret financial appraisal methods, and thermodynamic analysis, and estimate financial budget of visited industry.
CO4	Understanding of concept of co-generation
CO5	Able to select the insulation for thermal system and electrical utility

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Contents

Unit-I [6 Hrs]

Energy scenario: Introduction of energy scenario and its various forms, General energy problem, Energy use patterns, Energy balance. Energy Management Principles: Need, Organizing, Initiating and managing an energy management program. Energy Auditing: Elements and concepts, Types of energy audits, Instruments used in energy auditing.

Unit-II [6 Hrs]

Economic Analysis: Cash flows, Time value of money, Formulae relating present and future cash flows single amount, uniform series.

Unit-III [6 Hrs]

Financial appraisal methods: Payback period, Net present value, Benefit-cost ratio, Internal-rate of return & Life cycle costs/benefits. Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.

Unit-IV [6 Hrs]

Cogeneration: Concepts, Types of cogeneration systems, Performance evaluation of a cogeneration system. Waste Heat Recovery: Potential, benefits, waste heat recovery equipment's. Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning.

Unit-V [6 Hrs]

Industrial Insulation and Electric Utility: Insulation materials, Insulation selection, Economical thickness of insulation. Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), Energy costs and two – part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors.

Texts / Reference Books:

1. S.C.Tripathy: "Electric Energy Utilization and Conservation", TMG Delhi, 1991.
2. Wayne C. Turner: "Energy Management Handbook", Wiley Interscience Publication, NY,
3. D.A.Reay: "Industrial Energy Conservation", Pergamon Press. 1980.
4. T.L Boten: "Thermal Energy Recovery", Wiley, 1980.
5. Industrial Energy Conservation Manuals: MIT Press.
6. W.C.Turner, Energy Conservation Handbook.

Steam Engineering

MTE15B	Steam Engineering	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of Energy Conservation and management
2. To familiarize the students about the Energy audit and its applications in real life situations
3. To carry out a energy audit on the existed thermal system

Course Outcomes::

At the end of the course, student should be able to:

CO1	ability to explain working of different boilers and significance of mountings and accessories.
CO2	ability to use techniques, skills, and modern engineering tools necessary for boiler performance assessment.
CO3	theoretical and practical background in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation
CO4	ability to design a steam piping system, its components for a process and also design economical and effective insulation.

CO5	the ability to analyse a thermal system for sources of waste heat design a systems for waste heat recovery.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Introduction (6 hrs)

Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers ,Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards

Unit 2

Piping & Insulation (6 hrs)

Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

Unit 3

Steam Systems (6 hrs)

Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems.

Unit 4

Boiler Performance Assessment (6hrs)

Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

Unit 5

Energy Conservation and Waste Minimization (6hrs)

Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization

References:

1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons
3. Yunus A. Cengel and Boles, "Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co. Ltd
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency
5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency
6. Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company
7. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGrawHill Education Pvt Ltd, N Delhi

Pumps, Blowers and Compressors

	Pumps, Blowers and Compressors	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Outcomes::

At the end of the course, student should be able to:

CO1	To familiarize the students with latest developments in Pumps, compressors and blowers to cope up with requirements of industry.
CO2	To familiarize the students with developments in Pumps, compressor and blower
CO3	To provide a technical understanding of common engineering processes related with Pumps, compressor and blowers
CO4	To provide a technical understanding of use of computer and advanced tools related with Pumps, compressor and blowers
CO5	

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2			1	1		1		2				
CO3				1	1		1	2				1
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Centrifugal and Axial Flow Pumps [6 Hrs]

Law of momentum, Vortex theory of Euler‟s head. Hydraulic performance of pumps; Cavitation, Jet pumps. The centrifugal pump, definitions, pump output and efficiency, multistage centrifugal pumps, axial flow pump, Design of pumps.

Unit 2

Power Transmitting Turbo-machines [6 Hrs]

Introduction, theory, fluid of hydraulic coupling, torque converter.

Unit 3

Rotary fans and blowers [6 Hrs]

Introduction, Centrifugal blower, types of Vane shapes, Size and speed of Machine, Vane shape: efficiency, stresses, and characteristics. Actual performance characteristics, the slip co-efficient, Fan laws and characteristics.

Unit 4

Turbo blowers and their characteristics. [6 Hrs]

Cooling tower fan, Surging Design of blower sand fans.

Unit 5

Compressors: [6 Hrs]

Stage velocity triangles, enthalpy – entropy diagrams, flow through blade rows, stage losses and efficiency, work done factor, low hub-tip ratio stages, supersonic and trans sonic stages, performance characteristics, problems and design. Elements of centrifugal compressor stage, stage velocity diagrams, enthalpy-entropy diagram, nature of impeller flow, slip factor, diffuser, volute casing, stage losses, performance characteristics, problems and design.

Text Books

1.A.J. Stepanoff, Centrifugal and Axial /flow Pumps, Wiley, 1962.

2.A. Kovats, Design and Performance of Centrifugal and Axial Flow Pumps and Compressors, Oxford, Pergamon, 1958

3.V. Kadambi and Manohar Prasad: “An Introduction to energy conversion VolumeIII,2002

Reference Books

1.S M Yahya: “Turbines, Compressors and Fans”, Second Edition2.

V Ganesan: “Gas Turbines”, 2002.

Battery Thermal Management System

	Battery Thermal Management System	PEC	3-0-0	3 Credits
Exam Scheme				

Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks

Course Objective

- overview of electrochemistry, battery tenninologies,
- battery management system, charging and discharging for EV application and thennal management.
- learning about the battery system of electric & hybrid electric vehicles.
- lithium ion batte1y systems, chemistry, and management systems & cooling.

Course Outcomes::

At the end of the course, student should be able to:

CO1	illustrate major functions and parts of a battery-management system.
CO2	Design va1ious configurations of battery pack and recent trends in batte1y pack.
CO3	Compute stored energy in a batte1y pack.
CO4	Measure and control current, temperature, and isolation in battery-management
CO5	Knowledge of recent trends in batter management

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Couser Content

Unit 1

Energy and Electrochemistry: [6 Hrs]

Sources of energy for propulsion & their comparison: Net Calo1ific Value, Conversion efficiency, History and background of battery technology, Electrochemistry fundamentals & te1minologies, Lithium ion battery and different chemistries, Portable power applications and electrical load requirements, Factors affecting the choice of EV battery systems, Commercially available lithium ion cells, Electrical characteristics of battery: Capacity, C-rate, impedance, DOD, SOC, SOH, Life cycles, Mechanical characteristics, Fonn factor, Safety.

Unit 2

Battery Pack Construction: [6 Hrs]

Battery modules and complete battery pack system, Assembly methods, Electrical connections, Cell level protection system, batte1y pack level protection system, Understanding laptop battery pack system.

Unit 3

Battery Management System: [6 Hrs]

Introduction, Battery pack requirements: Measurement, Protection and management, Cell balancing, Battery pack electronics, Battery Management System (BMS): Functionality, technology and topology (centralized)
modular, master-slave, distributed).

Unit 4

Design of Battery Management System:

BMS Application Specific Integrated Circuit (ASIC) selection, Analog BMS design, Digital BMS design, BMS deploying: Installing, testing and Troubleshooting

Unit 5

Recent Trends and Economy:

Communication systems for battery pack, Review of electric car battery pack, Important considerations, Recent trends: Grid level energy storage, Solar & wind integration, Recycling and pricing.

Text Books:

Ibrahim Dinc;er, Halil S. Hamut, Nader Javani, Them1al Management of Electric Vehicle Battery Systems, ISBN: 978-1-118-90024-6.

• James Larrninie, Electric Vehicle Technology Explained, John Wiley & Sons.

Reference Books:

• Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modem Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press.

• Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes,
.http://nptel.ac.in/courses/l 08103009/

Research Methodology and IPR

	Research Methodology and IPR	OEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Objectives: Objectives of this course are

1. To select and define appropriate research problem and parameters with appropriate methodology.
2. To understand statistical techniques for the specific perspective data in an appropriate manner.

3. To make predictions and decisions for the data set using open-source software.
4. To understand the mathematical modeling and its predicting capability.
5. To learn the various steps in research writing and publication process and To introduce fundamental aspects of Intellectual property rights

Course Outcomes:

At the end of the course, student should be able to:

CO1	Define a research problem and use appropriate research methodology
CO2	Examine data using different hypothesis tests and make conclusions about acceptance or rejection of sample data.
CO3	Analyze numerical data, using standard procedures of probability theory to predict the performance.
CO4	Develop a mathematical model and analyze the prediction capabilities
CO5	Write a research paper and research proposal.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Research Problem and Research Design [6 Hrs]

Objectives, Motivation, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Criteria of Good Research Definition and Feasibility study of research problem, Sources of research problem, Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design

Unit 2

Applied Statistics [6 Hrs]

Measures of Variability: Standard Deviation, variance, Quartiles, Interquartile Range Inferential Statistics: Statistical Significance (p values), Pearson's r test, t- test, Chi square test,

Unit 3

Probability [6 Hrs]

Sampling, Types of Sampling, Probability Distribution: Binomial Distribution, Poisson Distribution, Normal Distribution, Case Study: Develop a model for Prediction and Decision Making for the data set using open-source software

Unit 4

Research Report writing and Publication [6 Hrs]

Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of referencing. Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.

Unit 5

Intellectual property Rights [6 Hrs]

Definition of IPR, Classification of IP, Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents. Prior Art Search, Patentability Criteria, Patent Filing Procedure, Forms and Fees, Case Study of Patent, Copyright.

Textbooks:

1. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International, 2nd Edition, 1985
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition.,2010.
3. Ramakrishna B and Anil Kumar H S., Fundamentals of IPR, Notion Press, 2016
4. Virendra Kumar Ahuja, IPR in India, LexisNexis Butterworths Wadhwa Nagpur, 2017

Reference Books:

1. Stuart Melville and Wayne Goddard, Research methodology: An Introduction for Science & Engineering Students
2. S.D. Sharma, Operational Research, Kadar Nath Ram Nath & Co.

Universal Human Values & Professional Ethics

	Universal Human Values & Professional Ethics	AC	2-0-0	Audit
Exam Scheme				
	Continuous Assessment 50 Marks			Total 50 Marks

Objectives:

After Completing this course, students are able

Outcomes:

CO1	
CO2	
CO3	
CO4	

CO5	

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1: Need, basic guidelines, contents and process for value education

• Understanding the need • basic guidelines • content and process for Value Education • Self-Exploration-what is it? – its content and process; 'Natural Acceptance' and Experiential Validationas the mechanism for self- exploration • Continuous Happiness and Prosperity- A look at basic Human Aspirations • Right understanding • Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority • Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario • Method to fulfil the above human aspirations: understanding & living in harmony at various levels

Unit 2: Understanding harmony in human being- harmony in myself YSELF

• The understanding human being as a co-existence of the sentient 'T' and the material 'Body • Understanding the needs of Self ('T') and 'Body' – Sukh and Suvidha • Understanding the Body as an instrument of 'T' (I being the doer, seer, and enjoyer) • Understanding the characteristics and activities of 'T' and harmony in T • Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs • Meaning of Prosperity in detail • Programs to ensure Sanyam & Swasthya.

Unit 3: Understanding harmony in family and society - harmony in human relationship

• Understanding harmony in the Family- the basic unit of human interaction. • Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay tripti; Trust (Vishwas) and Respect (Samman) as the foundational vales of relationship. • Understanding the meaning of Vishwas; Difference between intention and competence. • Understanding the meaning of Samman. • Difference between respect and differentiation; the other salient values in relationship. • Understanding the harmony in the society (society being an extension of • family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals. • Visualizing a universal harmonious order in society. • Undivided Society (Akhand Samaj). • Universal Order (Sarvabhaum Vyawastha) – from family to world family

Unit 4: Understanding harmony in the nature and in existence DERSTAINY

• Understanding the harmony in the Nature. • Interconnectedness and mutual fulfilment among the four orders of nature –recyclability and selfregulation in nature. • Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space. • Holistic perception of harmony at all levels of existence

Unit 5: Implications of the above holistic understanding harmony on professional ethics

• Natural acceptance of human values • The definitiveness of Ethical Human Conduct, • The basis for Humanistic Education, • Humanistic Constitution and Humanistic Universal Order, • Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and ecofriendly production systems • Technologies and management models, • Case studies of typical holistic technologies, • Management models and production systems, • Strategy for the transition from the present state to Universal Human Order: a) At the level of the individual: as socially and ecologically responsible engineers, Technologists and Managers, b) At the level of society: as mutually enriching institutions and organizations.

Textbooks/Reference Books:

1. A Foundation Course in Human Values and Professional Ethics, R. R. Gaur, R. Asthana, G. P. Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019, ISBN 978-93-87034-47-1

2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R. R. Gaur, R. Asthana, G. P. Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019, ISBN 97893- 87034- 53-2

Plastic Waste Management

	Plastic Waste Management	AC	2-0-0	Audit
Exam Scheme				
	Continuous Assessment 50 Marks			Total 50 Marks

Objectives:

After Completing this course, students are able

Outcomes:

CO1	Discuss the plastic waste sources nationally and worldwide and their production
CO2	Understand plastic waste management policy and its rules and regulations
CO3	Study the effect of plastic waste on health, environment of human and wildlife
CO4	Explain the recycling and energy conversion from plastic waste and application of waste plastics
CO5	Identify the alternatives to plastic as green resource and its economic impact

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2				1							
CO2			2			3	2	3				2
CO3	1		2									
CO4	2		1	1					1			1
CO5	1	2							1			

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Plastic and plastic types, uses of plastics, global statistics, plastic waste sources. Plastic waste sources production, Global sources of plastic waste and national sources of plastic waste

Unit 2

Plastic waste management rules 2016, Global rules and regulations, plastic bans including china sword policy implication on plastic global waste management, Plastic bans- global examples, plastic bans- china sword policy imparts, impact on global plastic waste management.

Unit 3

Impact of plastic pollution on marine life, plastic pollution impact on marine and wildlife, health and environmental impact of plastic pollution

Unit 4

Plastic waste management practices- recycling and waste plastic, Mechanical and feedstock recycling, pyrolysis and waste to energy, landfilling, other applications, use of waste plastic in road construction.

Unit 5

Possible alternate materials to plastics – Greener alternatives, Biodegradable plastics, Greener plastic products, Biobased plastic products, How to quantify something is green, plastic resource recovery and circular economy, plastics and circular economy – case studies

TEXTS/REFERENCES:

1. Plastic Waste Management by Murali Srinivasan and Natamai Subramaniam

2. The Circular Economy A User's Guide by Walter R Stahel. CRC Press 2019.

3. Waste to Wealth: The Circular Economy Advantage Peter Lacy, Jakob Rutqvist, 2015

4. Sustainable Practices for Landfill Design and Operation, Townsend, T.G., Powell, J., Jain, P., Xu, Q., Tolaymat, T., and Reinhart, D. (2015), Springer, USA

5. Recycling and recovery of plastics, Hanser Publishers, New York, 1996-R. Johanner Brandrup

6. Plastics Waste Management, Disposal Recycling and reuse, Marcel Dekker, Inc.New York,1993-Nabil Mustafa

7. Plastics and the Environment, Wiley Inter Science, New York (2003) – Anthony L.Andrady (Ed)

8. Plastics Recycling, Products and Processes, Hanser Publishers, New York,1992 –R.J. Ehrig

YOGA for Stress Management

	YOGA for Stress Management	AC	2-0-0	Audit
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Outcomes::

At the end of the course, student should be able to:

CO1	Gain the knowledge and practical skills necessary to achieve overall health of the body and mind through the practice of yoga
CO2	Develop effective stress management skills using yoga techniques and Explore various breathing techniques (pranayama) and understand their effects on the body and mind.
CO3	Master various yoga poses (asanas) and understand their benefits for both the mind and body.
CO4	Learn and apply the principles of Ahinsa, Satya, Astheya, Bramhacharya, and Aparigraha, as well as Shaucha, Santosh, Tapa, Swadhyay, and Ishwarpranidhan
CO5	Understand the Yam and Niyam as foundational principles guiding ethical and moral conduct, providing a framework for stress management in personal and professional life

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Couser Content

Unit-I

Definitions of Eight parts of yog.(Ashtanga)

Unit-II

Yam and Niyam.

Unit-III

Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Unit-IV

Asan and Pranayam

Unit-V

i)Various yoga poses and their benefits for mind &body ii) Regularization of breathing techniques and its effects-Types of pranayama.

Text Books:

1. 'Yogic Asanas forGroupTarining-Part-I": Janardan SwamiYogabhyasiMandal, Nagpur.
2. "Rajayogaor conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

Value Education

	Value Education	AC	0-0-0	Audit
Exam Scheme				
	Continuous Assessment 50 Marks			Total 50 Marks

Objectives:

After Completing this course, students are able

Outcomes:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Content

Unit I:
Value education-its purpose and significance in the present world – Value system – The role of culture and civilization – Holistic living – balancing the outer and inner – Body, Mind and Intellectual level – Duties and responsibilities.

Unit II:
Salient values for life – Truth, commitment, honesty and integrity, forgiveness and love, empathy and ability to sacrifice, care, unity, and inclusiveness, Self esteem and self confidence, punctuality – Time, task and resource management – Problem solving and decision making skills – Interpersonal and Intra personal relationship – Team work – Positive and creative thinking.

Unit III:
Human Rights – Universal Declaration of Human Rights – Human Rights violations – National Integration – Peace and non-violence – Dr.A P J Kalam's ten points for enlightened citizenship – Social Values and Welfare of the citizen – The role of media in value building.

Unit IV:
Environment and Ecological balance – interdependence of all beings – living and non-living. The binding of man and nature – Environment conservation and enrichment.

Unit V:
Social Evils – Corruption, Cyber crime, Terrorism – Alcoholism, Drug addiction – Dowry – Domestic violence – untouchability – female infanticide – atrocities against women – How to tackle them.

Books for Reference:
1. M.G. Chitakra: Education and Human Values, A.P.H. Publishing Corporation, New Delhi, 2003.
2. Chakravarthy, S.K: Values and ethics for Organizations: Theory and Practice, Oxford University Press, New Delhi, 1999.
3. Satchidananda, M.K: Ethics, Education, Indian Unity and Culture, Ajantha Publications, Delhi, 1991.
4. Das, M.S. & Gupta, V.K.: Social Values among Young adults: A changing Scenario, M.D. Publications, New Delhi, 1995.
5. Bandiste, D.D.: Humanist Values: A Source Book, B.R. Publishing Corporation, Delhi, 1999.
6. Ruhela, S.P.: Human Values and education, Sterling Publications, New Delhi, 1986.
7. Kaul, G.N.: Values and Education in Independent Indian, Associated Publishers, Mumbai, 1975.
8. NCERT, Education in Values, New Delhi, 1992.
9. Swami Budhananda (1983) How to Build Character A Primer :Rmakrishna Mission, New Delhi.
10. A Culture Heritage of India (4 Vols.), BharatiyaVidyaBhuvan, Bombay, (Selected Chapters only)
11. For Life, For the future : Reserves and Remains – UNESCO Publication.
12. Values, A Vedanta Kesari Presentation, Sri Ramakrishna Math, Chennai, 1996.
13. Swami Vivekananda, Youth and Modern India, Ramakrishna Mission, Chennai.
14. Swami Vivekananda, Call to the Youth for Nation Building, AdvaitaAshrama, Calcutta.
15. Awakening Indians to India, Chinmayananda Mission, 2003

SEMESTER II

Advanced Fluid Mechanics

	Advanced Fluid Mechanics	PEC	3-1-0	4 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Outcomes::

At the end of the course, student should be able to:

CO1	Students will familiarize with properties of fluids and their influence on the operation of various fluid flow applications
CO2	Students will analyze governing equestrians, pressure variation and pressure loss due to friction in flowing fluid
CO3	Students will identify forces due to flow of fluids over bodies using boundary layer theory
CO4	To provide a technical understanding of use of computer and advanced tools related with Advanced Fluid Mechanics
CO5	Students will develop skill to analyze various fluid flows using latest fluid simulation techniques

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Couser Content

Unit 1

Concept of Continuum & Fluid: [6 Hrs]

Body and Surface Forces, Scalar and Vector fields, Eulerian and Lagrangian description of flow, Motion of Fluid element- Translation, Rotation& Velocity **Governing Equations:** Mass conservation in differential and integral forms, Flow kinematics, and Momentum equation: substantial derivative, differential and integral Form, stress tensor, stress strain relations, Ideal Fluid flow concepts

Unit 2

Mechanics of Laminar Flow: **[6 Hrs]**

Introduction Laminar and Turbulent flows, Viscous flow at different Reynolds number-wake frequency, Laminar plane Poiseuille flow, stokes flow, Flow through Concentric annulus, Laminar Flow in Pipes and Channels

Unit 3

Navier-Stokes Equations: [6 Hrs]

Special forms: Euler equations, Bernoulli equation, stream function, vorticity. Exact solutions: fully developed flow in channel, pipe, flow between concentric rotating cylinders, Couette flow, Stokes First problem (unsteady flow), Creeping

Unit 4

Turbulent flow: [6 Hrs]

Introduction to hydrodynamic stability, characteristics of turbulence governing equations, turbulent boundary layer, algebraic models (Prandtl's mixing length), and velocity profile over a flat plate and in pipes

Turbulent Shear Flows: Equations for free shear layers: mixing layer, plane and axis symmetric jet, wake. Turbulent energy equation, two equation model(k-epsilon), Large Eddy Simulation, Various Turbulent Models

Unit 5

Compressible Flow: **[6 Hrs]**

One-dimensional Flow: speed of sound, variable cross- section flow, converging diverging nozzle, effect of friction and heat transfer, normal shock relations, Introduction to oblique shocks, 2-dimensional flows (subsonic and supersonic) past slender bodies, compressible boundary layers.

Text Books

1. Mohanty A.K.: Fluid Mechanics, II edition, PHI private Ltd. New Delhi
2. E. Radhakrishnan: Fluid Mechanics, II edition, PHI private Ltd. New Delhi
3. James A. Fay: Introduction to Fluid Mechanics, PHI private Ltd. New Delhi
4.Streeter: Fluid Mechanics, Tata McGraw Hill, New Delhi

Reference Books

1.Schlichting: Boundary layer theory, Springer Pub
2.G. Biswas and K. Muralidhar: Advanced Fluid mechanics, Alpha Science International Ltd. Publisher
3.Fox R.W. and McDonald A.T: Introduction to Fluid Mechanics John Wiley & Sons
4.Bird R.B. Stewart W.F.: “Transport Phenomena”, John Wiley & Sons

Numerical Methods & Computational Techniques

	Numerical Methods & Computational Techniques	PCC	3-1-0	4 Credits

Exam Scheme			
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks

Course Outcomes: At the end of the course, student should be able to

CO1	Apply the methods for solving algebraic, transcendental and linear equations.
CO2	Solve single variable optimization problems
CO3	Apply the methods for curve fitting using regression and interpolation techniques.
CO4	Apply the methods to solve differentiation and integration numerical.
CO5	solve ordinary and partial differential equations

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Roots of Functions and Linear Equations: [6 Hrs]

Transcendental & Algebraic Equations: Bracketing & open Methods- Bisection, False Position, Newton Rapshon Method, Secant Method. Gauss Elimination, Gauss Jordon applications, Gauss Seidal, LU decomposition,
Matrix Inversion.

Unit 2

Single Variable Optimisation: [6 Hrs]

Single variable optimization: Optimality Criterion, Bracketing methods - Exhaustive Search Method, Bounding Phase Method, Region Elimination Method - Interval Halving Method, Fibonacci Search Method, Golden Section Search Method, Point Estimation Method - Successive quadratic estimation method, Gradient based methods - Newton - Raphson Method, Bisection Method, Secant Method., Cubic Search Method

Unit 3

Curve Fitting: [6 Hrs]

Regression analysis - Least square method, Linear regression, Polynomial regression, Fouries regression, Non linear regression, Interpolation - Newton's forward and backward interpolation, Newton's divided difference interpolation,
Lagrange's interpolation, Gauss's central difference interpolation

Unit 4

Numerical Integration and Differentiation: [6 Hrs]

Newton Cotes Integration fonnulas- Trapezoidal, Simpson, Romberg, Gaussian Quadrature, Numerical Differentiation-Finite Difference Method. Types of Differential equations, Picard's Series Method, Taylor Series Method, Euler's Method, Modified Euler's Method, Runge Kutta Method, Predictor Corrector Method, Milnes Method, and Application to Initial & Boundary value , Problems

Unit 5

Partial Differential Equations: [6 Hrs]

Introduction to PDE Elliptic, Parabolic & Hyperbolic Equation. Finite Difference Schemes, Foiward, Backward, Central Difference, Application to Laplace & Poisson's Equation, Iterative & Relaxation Techniques, Laplacian Operator in Cartesian, polar and other coordinate systems. Solution of Parabolic Equations, Implicit & Explicit Schemes, Crank Nicholson, ADI scheme. Solution of Hyperbolic Equations.

Text Books:

- Larry C. Andrews, Ronald L. Phillips, Mathematical Techniques for Engineers and Scientists, , Prentice Hall of India Private Ltd. New Delhi.
- Numerical Mathematical analysis, James B. Scarborough, Oxford and IBH Publishing Ltd
- Optimization for Engineering Design - Algorithms and Examples, Kalyanmayi Deb, PHI Pvt. Ltd

Reference Books:

- Numerical Methods by Engineers by Steven C Chapra and Raymond P Canale, TMH Publications.
- Numerical Methods for Engineers and Scientists, J D Hoffman, Marcel Dekker.
- Numerical Methods, B. S. Garewal, Khanna Publishers

Mini Project

	Mini Project	PCC	0-0-2	1 Credits
Exam Scheme				
CA 20 Marks	CA 20 Marks	PR/OR Marks	60	Total 100 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	Identify methods and process to carry out experiments/develop equations.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		2	2	1	1	2	2	2	2
CO2	1	1	2	2			2	2	1	2	2	2
CO3	2	2		3					2	2	2	1
CO4				2				2	2	3	3	1
CO5		1		2	2			2	2	3	3	1

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Objectives:

To train students in identification, analysis, finding solutions and execution of live engineering and managerial problems. It is also aimed to enhance the capabilities of the students for group activities. Individual students are required to choose a topic of their interest. The course content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from manufacturing organizations as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50.

Internal marks will be awarded by respective guides as per the stipulations given below.

Attendance, regularity of student (20 marks)

Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, beforethe committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

Report = 25 marks

Concept/knowledge in the topic = 15 marks,

Presentation = 10 marks,

Total marks = 50 marks

Seminar

	Seminar	PCC	0-0-2	1 Credits
Exam Scheme				
CA 20 Mark	CA 20 Marks	PR/OR 60 Marks		Total 100 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	Identify and compare technical and practical issues related to the area of course specialization
CO2	Outline annotated bibliography of research demonstrating scholarly skills
CO3	Prepare a well-organized report employing elements of technical writing and critical thinking
CO4	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		1	2		2	2	2	1	2
CO2		2				2		1	2	1		1
CO3						1	1	2	2	2		2
CO4	1	2	1	1		1	1	1	2	1		1

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Objective: To assess the debating capability of the student to present a technical topic. Also, to impart training to a student to face audience and present ideas and thus creating self-esteem, self-confidence and courage that are essential for an engineer. Individual students are required to choose a topic of their interest from Automation & Robotics related topics preferably from outside the M.Tech syllabus or an extension of syllabus and give a seminar on that topic for about 30 minutes. The Seminar can also be a case study from a automation or robotics organization. A committee consisting of at least three faculty members shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Indian Knowledge System: Concepts and Applications in Engineering

	Mini Project		PCC	2-0-0	2 Credits
Exam Scheme					
CA 1: 25 Marks		CA 2: 25 Marks		PR/OR Marks	Total 50 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	Discuss need, history and features of IKS and various aspects of vedas, kalpa and jyotisa
CO2	Understand the number system, indian mathematics and astronomy and their contribution
CO3	Explain ancient metals and metal working practices and applications of engineering and technology
CO4	Describe town planning and architecture of ancient india and ancient knowledge system
CO5	Understand various features of linguistics and Sanskrit role in language processing

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution Course

Contents:

Unit-1 Indian Knowledge System – An Introduction: 1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS The Vedic Corpus: 1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Subclassification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2 Number Systems and Units of Measurement: 1. Number systems in India - Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system Mathematics: 1. Introduction to Indian Mathematics 2. Unique aspects of Indian Mathematics 3. Indian Mathematicians and their Contributions 4. Algebra 5. Geometry 6. Trigonometry 7. Binary mathematics and combinatorial problems in Chandaḥ Śāstra 8. Magic squares in India Astronomy: 1. Introduction to Indian astronomy 2.

Indian contributions in astronomy 3. The celestial coordinate system 4. Elements of the Indian calendar 5. Notion of years and months 6. Pañcāṅga – The Indian calendar system 7. Astronomical Instruments (Yantras) 8. Jantar Mantar of Rājā Jai Singh Sawai.

Unit-3 Engineering and Technology: Metals and Metalworking: 1. Wootz Steel: The rise and fall of a great Indian technology 2. The Indian S & T heritage 3. Mining and ore extraction 4. Metals and metalworking technology 5. Iron and steel in India 6. Lost wax casting of idols and artefacts 7. Apparatuses used for extraction of metallic components Engineering and Technology: Other applications: 1. Irrigation systems and practices in South India 2. Literary sources for science and technology 3. Physical structures in India 4. Irrigation and water management 5. Dyes and painting technology 6. The art of making perfumes 7. Surgical techniques 8. Shipbuilding 9. Sixty-four art forms (64 Kalās) 10. Status of Indigenous S & T.

Unit-4 Town Planning and Architecture: 1. Perspective of Arthaśāstra on town planning 2. Vāstuśāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography. Knowledge Framework and classifications: 1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas – the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study

Unit-5 Linguistics: 1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing.

TEXTBOOKS /REFERENCES:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi. For additional reading: 1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
2. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
3. Bag, A.K. (1979). Mathematics in Ancient and Medieval India, Chaukhamba Orientalia, New Delhi.
4. Datta, B. and Singh, A.N. (1962). History of Hindu Mathematics: Parts I and II, Asia Publishing House, Mumbai.
5. Kak, S.C. (1987). "On Astronomy in Ancient India", Indian Journal of History of Science, 22(3), pp. 205–221.
6. Subbarayappa, B.V. and Sarma, K.V. (1985). Indian Astronomy: A Source Book, Nehru Centre, Mumbai. 7. Bag, A.K. (1997). History of Technology in India, Vol. I, Indian National Science Academy, New Delhi.
8. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
9. Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
10. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P

Indian Knowledge System: Humanities and Social Sciences

	Mini Project	PCC	2-0-0	2 Credits
Exam Scheme				
CA 1: 25 Marks	CA 2: 25 Marks	PR/OR Marks		Total 50 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	Discuss need and salient features of IKS and various vedas
CO2	Understand ancient philosophical systems and wisdoms of ages like itihas, shastra, puranas
CO3	Classify Indian knowledge framework and linguistics
CO4	Explain number systems and measurement units, Ayurvedic and disease management
CO5	Explain town planning and Architecture practices of vastu and temples and public administration

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution Course

Contents:

Unit-1

Indian Knowledge System – An Introduction: 1. What is IKS? 2. Why do we need IKS? 3. Organization of IKS 4. Historicity of IKS 5. Some salient aspects of IKS The Vedic Corpus: 1. Introduction to Vedas 2. A synopsis of the four Vedas 3. Subclassification of Vedas 4. Messages in Vedas 5. Introduction to Vedāṅgas 6. Prologue on Śikṣā and Vyākaraṇa 7. Basics of Nirukta and Chandas 8. Introduction to Kalpa and Jyotiṣa 9. Vedic Life: A Distinctive Features

Unit-2

Philosophical Systems: 1. An introduction to philosophical systems 2. Development of philosophy 3. Unique features of philosophy 4. Sāṅkhya approach of philosophy 5. Introduction to Yoga 6. Tenet of Nyāya philosophy 7. Principles of Vaiśeṣika 8. Doctrine of Pūrva-Mīmāṃsā Darśana 9. Thesis of Vedānta and synopsis of Advaita 10. Philosophy of Viśiṣṭādvaita 11. Ideology of Dvaita 12. Tenets of Jaina 13.

Doctrine of Buddhism 14. Notions of Cārvāka Wisdom through the Ages: 1. Gateways of ancestral wisdoms 2. Introduction to Purāṇa 3. The Purāṇic repository 4. Issues of interest in Purāṇas 5. Introduction to Itihāsas 6. Key messages in Itihāsas 7. Wisdom through Nīti-śāstras 8. Wisdom through Subhāṣita

Unit-3

Knowledge Framework and classifications: 1. Indian scheme of knowledge 2. The knowledge triangle 3. Prameya – A vaiśeṣikan approach to physical reality 4. Dravyas –the constituents of the physical reality 5. Attributes – the properties of substances and Action – the driver of conjunction and disjunction 6. Sāmānya, viśēṣa, samavāya 7. Pramāṇa – the means of valid knowledge 8. Saṃśaya – ambiguities in existing knowledge 9. Framework for establishing valid knowledge 10. Deductive or inductive logic framework 11. Potential fallacies in the reasoning process 12. Siddhānta: established tenets in a field of study Linguistics: 1. Introduction to Linguistics 2. Aṣṭādhyāyī 3. Phonetics 4. Word generation 5. Computational aspects 6. Mnemonics 7. Recursive operations 8. Rule based operations 9. Sentence formation 10. Verbs and prefixes 11. Role of Sanskrit in natural language processing

Unit-4

Number Systems and Units of Measurement: 1. Number systems in India – Historical evidence 2. Salient aspects of Indian Mathematics 3. Bhūta-Saṃkhyā system 4. Kaṭapayādi system 5. Measurements for time, distance, and weight 6. Piṅgala and the Binary system Health Wellness and Psychology: 1. Introduction to health 2. Āyurveda: approach to health 3. Saptadhātavaḥ: seven-tissues 4. Role of agni in health 5. Tri-doṣas 6. Āyurveda: definition of health 7. Psychological aspects of health 8. Disease management elements 9. Dinacaryā: daily regimen for health & wellness 10. Importance of sleep 11. Food intake methods and drugs 12. Approach to lead a healthy life 13. Indian approach to psychology 14. The tri guṇa system & holistic picture of the individual 15. The Nature of Consciousness 16. Consciousness studies and issues

Unit-5

Town Planning and Architecture: 1. Perspective of Arthaśāstra on town planning 2. Vāstu-śāstra – The science of architecture 3. Eight limbs of Vāstu 4. Town planning 5. Temples in India: marvelous stone architecture for eternity 6. Temple architecture in India 7. Iconography Governance and Public Administration: 1. Introduction to raja dharma 2. Arthaśāstra: a historical perspective 3. Elements of a kauṭilyan state 4. The king & the amātya 5. Janapada & durga 6. Treasury and the State Economy (Kośa) 7. Danda 8. Mitra 9. The Administrative Setup 10. Relevance of Arthaśāstra 11. Public Administration in Epics

TEXTBOOKS /REFERENCES:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi. Additional Readings:
1. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
2. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
3. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.

4. Kapoor Kapil, Singh Avadhesh (2021). “Indian Knowledge Systems Vol – I & II”, Indian Institute of Advanced Study, Shimla, H.P.
5. Dasgupta,S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.
6. PLofker, K. (1963). Mathematics in India, Princeton University Press, New Jeresy, USA"

Ancient Indian Management

	Mini Project	PCC	2-0-0	2 Credits
Exam Scheme				
CA 1: 25 Marks	CA 2: 25 Marks	PR/OR Marks	Total 50 Marks	

Course Outcomes:

At the end of the course, student should be able to:

CO1	Understand nature and art of management
CO2	Explain about the jain and vedantic literature and its code of conduct
CO3	Understand management from Bhagwat Gita
CO4	Discuss the management lessons from Ramayana
CO5	Explain the economics from Koutilya and Mahavira Dynast

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution Course

Contents:

Unit-1

Introduction Understanding management: Defining management, Nature of management, Management: Science or art? Ancient Indian Management

Unit-2

Management Perspective of Ancient Indian Literature: What is Jain Literature?, What is Vedantic Literature?, code of conduct in vedantic literature, code of conduct in Jain Literature, Four pillars of human labor in ancient Vedantic and Jain Literature Management lessons from Mahabharata

Unit-3

Management in Bhagavad Gita: • Introduction to Gita • Management Lessons from Bhagavad Gita,

Unit-4

Management lessons from Ramayana: • Introduction to Ramayana, • Management Lessons from Ramayana

Unit-5

Ancient Indian Economics: • Kautilya's economics • Mahavira's economics

TEXTBOOKS / REFERENCES:

1. Indian Management by Subhash Sharma. New Age International (P) Limited Publishers< New Delhi ISBN: 978-93-89802-41-2

2. Management Concepts - In Ancient Indian Psycho-Philosophic Thought &Thier Significance for Present Day Organisations by Ipshita Bansal, Popular Book Depo

3. In Indian Logic: Modern Management Philosophies as derived from Ancient Indian Philosophies, by Aparna Singh

Conservation of Energy in Buildings

	Conservation of Energy in Buildings	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Objectives:

1. To develop a multidisciplinary approach to the energy supply and use in new and existing buildings
2. To develop knowledge and understanding of system solutions that provide optimal indoor environment in buildings in an environmentally and cost-effective way
3. To create awareness of different building rating tools

Course Outcomes::

At the end of the course, student should be able to:

CO1	Should be able to identify features of an energy efficient building system
CO2	Learner should be able to apply simulation programs of buildings to perform energy calculations,

	evaluate the relationship between energy use, indoor comfort
CO3	
CO4	Learner should be able to evaluate and justify energy-saving measures in existing building on the basis of engineering and economic feasibility
CO5	Learner should be able to apply the principles of energy management to obtain buildings that can be certified

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Aspects of efficient building design

Solar geometry, climate responsive building design, Solar passive features Fundamentals of building acoustics, Quality indicators, Acoustic materials, Noise control, Effective day lighting design, Daylight Simulation, Thermal comfort, requirements of ASHARE standard 55

Unit 2

Design of Building systems

Mechanical systems design - heating cooling load calculations, comparison of software, energy simulation, Introduction Electrical systems design, Introduction to plumbing systems design, Other energy sources (DG Sets, Solar PV, Solar thermal) Integrated building design, introduction to BIM

Unit 3

High Performance Building Systems

Introduction to high performing buildings, Methods and tools - rating systems (like LEED), Synergies between IAQ and energy efficiency, HVAC Controls, Protocols, overview of building management systems, New trends: IoT, data analytics, Fault detection & diagnostics

Unit 4

Energy performance analysis of buildings

ASHRAE Level 1,2,3 energy audits, Commissioning of building systems, measurement and verification (IPMVP),Benchmarking tools such as energy star portfolio manager, Eco-Niwas Samhita, ASHRAE Building EQ

Unit 5

Building Energy Simulations

Introduction, Overview of software and simulation engines, Introduction to eQuest Energy modelling inputs, reviewing data, quality control process, note making and assumptions, Energy simulation for design optimization, code compliance, benchmarking, and calibration, Best practices for energy simulation experts, Program certifications and credentials

Text Books:

1. N. K. Bansal, G Hauser, G. Minke, Passive building design: A handbook of Natural climatic control, Elsevier Science Ltd, 1994.
2. Manual on solar passive architecture: energy systems Engineering, IIT Delhi and Solar Energy Centre, Ministry of Non-conventional Energy Sources, Government of India, New Delhi
3. K. Sasikumar, S. Gopi Krishna Solid Waste Management, PHI (EEE) , 2013.
4. D. J. Harris, A Guide to Energy Management in Buildings, Spoon Press Energy Efficiency, Routledge; 1st edition ,2011.
5. M. Yang, X. Yu, Benefits for Environment and Society, Green Energy and Technology, Springer, 2015.

Reference Books:

1. Uses of landscaping for energy conservation Giani, Florida: Department of Physical Sciences, Florida International University
2. TERI report 96RT__ Window design optimisation
3. E. Mazria, The Passive Solar Energy book, Rodale Press, Pennsylvania, 1979
4. M. E Levy, D. Evans and C. Gardstein, The Passive Solar Construction Handbook, Rodale Press, Pennsylvania, 1983.
5. MIT Building Systems Design Handbook, Version 1.2 (Building Components)
6. MEP Databook Hardcover Sidney M. Levy
7. eQuest resources from doe2.com
8. ASHRAE Standard 90.1-2010, 2016
9. Green building rating system manuals – IGBC, LEED V4 BD+C, GRIHA V2015
10. Energy Conservation Building Code (ECBC) 2017
11. International Performance Measurement and Verification Protocol (IPMVP), NREL
12. ASHRAE Guideline 0 – The Commissioning Process and ASHRAE Standard 202
13. ASHRAE Technical Articles, research papers and case studies on relevant topics
14. IEA (International Energy Agency) – Building Optimization and Fault Diagnosis Source Book (IEA ANNEX 25)
15. Energy Efficiency Guide for Existing Commercial Buildings – The Business case for Building Owners and Managers – Dennis Landsberg, Mychele Lord, Steve Carlson, Fredric Goldner – ASHRAE / AIA / IESNA /USGBC

Cryogenic Engineering

	Cryogenic Engineering	PEC	3-0-0	3 Credits

Exam Scheme			
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks

Course Outcomes::

At the end of the course, student should be able to:

CO1	Understand the Properties of cryogenic fluid
CO2	Able to know gas liquification system
CO4	Study cryogenic insulation working process
CO5	Different cryogenic equipment

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Refrigeration and liquefaction principals;

Joule Thomson effect and inversion curve;

Adiabatic and isenthalpic expansion with their comparison.

Properties of cryogenic fluids; Properties of solids at cryogenic temperatures;

Superconductivity.

Unit 2

Gas liquefaction systems:

Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.

Unit 3

Cryogenic insulation:

Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

Unit 4

Storage of cryogenic liquids;

Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems.

Cryogenic instrumentation: Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

Unit 5

Cryogenic equipment:

Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization.

RECOMMENDED BOOKS

1. Cryogenics: Applications and Progress, A. Bose and P. Sengupta, Tata McGraw Hill.
2. Cryogenic Engineering, T.M. Flynn, Marcel Dekker
3. Handbook of Cryogenic Engineering, Editor – J.G. Weisend II, Taylor and Francis
4. Cryogenic Systems, R. Barron, Oxford University Press.
5. Cryogenic Process Engineering, K.D. Timmerhaus and T.M. Flynn, Plenum Press.
6. Cryogenic Fundamentals, G.G. Haselden, Academic Press.
7. Advanced Cryogenics, Editor – C.A. Bailey, Plenum Press.
8. Applied Cryogenic Engineering, Editors – R.W. Vance and W.M. Duke, John Wiley & sons.

Advanced Optimization Techniques

	Advanced Optimization Techniques	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Objectives:

1. To introduce students to the modeling of constrained decision-making problems and optimization.
2. Provide students with the basic mathematical concepts of optimization.
3. Provide students with the modelling skills necessary to describe and formulate optimization problems.
4 Provide students with the skills necessary to solve and interpret optimization problems in engineering.

Course Outcomes::

At the end of the course, student should be able to:

CO1	Formulate mathematical programs in various practical systems
CO2	Understand basic optimization techniques
CO3	interpret the results of a model and present the insights (sensitivity, duality)
CO4	Know the limitations of different solution methodology
CO5	Use software to solve problems

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1.
Classical Optimization Techniques
Introduction to Mathematical Modeling, Single variable optimization and multi variable optimization, with constraints and without constraints

Unit 2.
Linear and non-Linear Programming
Simplex Methods, Elimination and iterative methods for one-dimensional minimization .

Unit 3.
Simulation Modeling
Introduction, definition and types, limitations, various phases of modeling, Monte Carlo method, applications, advantages and limitations of simulation

Unit 4.
Modern Methods of Optimization
Genetic algorithms, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, etc.

Unit 5
ANOVA:
One-way, two-way with/without interactions. Anova technique, principles of design of experiment: some standard designs such as Latin-square design (LSD), completely randomized design (CRD), and randomized block design
(RBD).

Text Books:

1. Engineering Optimization: Theory and Practice, Singiresu S. Rao, John Wiley & Sons
2. Practical Optimization Methods with Mathematical Applications, M. Asghar Bhatti, Springer
3. Optimization for engineering design, K. Deb, PHI

Reference Books:

1. Topology Optimization – Theory, Methods and Applications, M. P. Bendse, Q. Sigmund
2. Evolutionary Topology Optimization of Continuum Structures, Methods and Applications, X. Huang, Y.M. Xie, Wiley
3. Structural Optimization, Raphael T. Haftka and Zafer Gurdal, Kluwer Academic Publishers
4. Mathematical Modelling, J N Kapur, New age international publication
5. Optimization concepts and applications in engineering, Belegundu, Chandrupatla, Pearson Education

Design of Thermal System

	Design of Thermal System	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Description

- Design concepts and fundamental aspects of industrial thermal system simulation and optimization.
- Examination of optimum design criteria, their application and scrutiny of engineering decision.
- Fundamentals of design, and selection of the all equipment and processes such as heat exchangers, evaporators, condensers, boilers, binary mixtures and turbo machinery.
- Mathematical modelling of them al equipment.
- Simulation of thermal systems. Fundamentals of optimum system design.
- Optimization methods and optimization of them1al systems.

Course Outcomes::

At the end of the course, student should be able to:

CO1	Illustrate basic principles of modeling and optimization of design of thennal systems.
CO2	2Design thermal systems.
CO3	Analyze thermal system.
CO4	Understand system simulation
CO5	Study Optimization of Thermal Systems

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Couser Content

Unit 1

Design Concepts: [06Hrs]

Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor. Computer aided thermal system design.

Unit 2

Mathematical Modeling[06Hrs]

Equation fjtting, Nomography, Empirical Equation, Regression Analysis, Different Modes of Mathematical Models.

Unit 3

Modeling Thermal Equipments: [06Hrs]

Different Modes of Mathematical Models, Selection, and Computer Programs for Models. One case study type complete example for Modelling out of following: Heat Exchangers, Evaporators, Condensers, Absorption and Rectification Columns, Compressors, Pumps.

Unit 4

Simulation of Thermal Systems: [06Hrs]

Uses of system simulation, classes of simulation; Information-flow diagrams; sequential and simultaneous calc1:1lations; simulation of continuous,

Unit 5

Optimization of Thermal Systems: [06Hrs]

Optimization criteria; use of Lagrange Multipliers, search methods, dynamic programming and geometric programming for optimum design of thermal systems. Steady state Simulation, Laplace Transfonnation, Feedback Control Loops, Stability, Analysis.

References:

Text Books:

• Stoecker W. F., Design ofThen11al Systems, McGraw Hill Edition.
• Bejan A., The1mal Design and Optimization, George Tsatsaronis, Michael J. Moran, Wiley.
• Hodge, B.K., Analysis & Design ofThem1al Systems, Prentice Hall.

• Boehm, R.F., Design of Thermal Systems, John Wiley.

Reference Books:

• Kapur J. N., Mathematical Modelling, Wiley Eastern Ltd, New York.
• Y ogesh J aluria, Design and Optimization of Thermal Systems, CRC Press.
• Rao S. S., Engineering Optimization Theory and Practice, New Age Publishers

Nanotechnology

	Nanotechnology	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Objectives:

1. To introduce advanced and exotic materials.
2. To familiarize students with structure and properties of materials.
3. To establish significance of material selection in engineering design.
4. To explore new design opportunities.

Course Outcomes:

At the end of the course, student should be able to:

CO1	analyze of different materials in advanced engineering application.
CO2	relate structure and properties of new materials in engineering applications
CO3	evaluate and select materials for advanced engineering applications.
CO4	Understand characterization of nano material
CO5	enable students to understand the applications of nano materials and associated technology in industrial sector.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Advanced and exotic materials – ceramics and Plastics, Biomaterials, Aerogels, Superconductors, Carbon nano tubes

Unit 2

Mechanical, electrical, optical and magnetic properties of materials.

Unit 3

Smart materials, Piezoelectricity, Magnetostriction, smart polymers, Shape memory alloys

Unit 4

introduction to nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterizations of nanomaterials.

Unit 5

Industrial Applications of Nanomaterials

Nano-Electronic Technologies Nano capacitors, Quantum tunneling, Single electron transistors, Coulomb blockade, Nano lithography, Data storage, Nano-photonics, Nano electronic and Magnetic devices, Spintronic, Carbon based materials: Carbon Nano-tube (CNC), Graphene. Sensors & Nano-sensors.

Text Books:

1. W.D. Callister Material Science and Engineering: An Introduction, Wiley publication.

Reference Books:

1. Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
2. L.F. Pease, R.M. Rose and J. Wulff, Electronic Properties (Volume IV: Structure and Properties of Materials)

Thermal Energy Storage

	Thermal Energy Storage	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Objectives:

To provide the sufficient knowledge of concept, applications, importance of Thermal energy storage

To familiarize the students about the design of thermal energy storage systems

To understand the industrial applications of thermal energy storage

Course Outcomes:

At the end of the course, student should be able to:

CO1	Select thermal storage systems and the storage materials
CO2	Develop a model and analyze the the1mal storage systems
CO3	Explain applications of thermal storage systemsx
CO4	Study on Modeling of phase change problems
CO5	Modeling and analysis usmg numerical codes

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1
Introduction:
Necessity of them1al storage - types-energy storage devices - compatison of energy storage technologies - seasonal them1al energy storage - storage materials

Unit 2
Sensible Heat Storage System:
Basic concepts and modeling of heat storage units - modeling of simple water
and rock bed storage system - use of TRNSYS - pressmized water storage system for power plant applications - packed beds

Unit 3
Regenerators:
Parallel flow and counter flow regenerators - finite conductivity model – non linear model - transient performance step changes in inlet gas temperature - step changes in gas flowfrate ·-. arameterization of transient
response - heat storage exchangers

Unit 4
Latent Heat Storage Systems:

Modeling of phase change problems - temperature-based model - enthalpy model - porous medium approach - conduction dominated phase change - convection dominated phase change

Unit 5

Modeling of system and Applications:

Simple cases studies of energy storage. Modeling and analysis usmg numerical codes.
Specific areas of application of energy storage - food preservation – waste heat recovery - solar energy storage - green house heating - power plant applications - drying and heating for process industries

References:

Text Books:

J Ibrahim Dincer and Mark A. Rosen, The1111al Energy Storage Systems and Applications, John Wiley & Sons.

Reference Books:

Schmidt.F.W and Wilhnott.A.J, Thermal Storage and Regeneration, Hemisphere Publishing Corporation.

Lunardini.V.J, Heat Transfer in Cold Climates, JoJm Wiley and Sons.

Steam & Gas turbine

	Steam & Gas turbine	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To provide the sufficient knowledge of working, construction and control of ST and GT
2. To familiarize the students about the industrial applications of ST and GT
3. To understand the analysis of GT and ST employing real life data

Course Outcomes:

At the end of the course, student should be able to:

CO1	Illustrate properties of Steam, Draw P-V, T-s, H-s(Mollier) diagrams for steam, Describe Theoretical steam turbine cycle.
CO2	Demonstrate and analyze vortex flow, energy lines and reheat factors of steam turbines. Solve problems of finding performance steam turbine power plant.
CO3	Demonstrate simple Brayton cycle for gas turbine analyze its performance on computer simulation, suggest suitable modification and then analyze it.
CO4	Study and apply various Performance Improvement Techniques in steam and gas Turbines

CO5	Design and suggest and analyze cooling accessories and protective material for steam turbine.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2		2										
CO3	1	1		3	1							
CO4	2	1			2	1						
CO5	1	1		1	1							

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit I

Introduction and Steam Turbine

Introduction, properties of steam, steam quality, Theoretical steam turbine cycle. The flow of steam through Impulse and Impulse–Reaction turbine blades, compounding of steam turbine.

Unit II

Performance of Steam Turbine

Vortex flow in steam turbines, Energy lines, State point locus, Reheat factor and Design procedure. Governing and performance of steam turbine, Effect of operating variables on thermal efficiency.

Unit III

Nozzle

Steam nozzles, Turbine Blade-Design, Selection of blade profile, blade cooling techniques, material, protective coating.

Unit IV

Gas Turbine

Gas turbine Introduction, simple open cycle gas turbine, Actual Brayton cycle, Means of Improving the efficiency and the specific output of simple cycle, Regeneration, Reheat, Intercooling,

Unit V

Performance of Gas Turbine

closed-cycle gas turbine,turbine velocity diagram and work done, Performance improvement, Effect of operating variables on thermal efficiency.

TEXTS / REFERENCES:

1. W.J.Kearton, *Steam Turbine Theory and Practice*, ELBS.
2. R.Yadav, *Steam and Gas Turbine*, Central Publishing Home, Allahabad.
3. Jack D. Mattingly., *Elements of Gas Turbine propulsion*, McGraw – Hill Pub.,
4. Cohen Rogers, *Gas Turbine Theory*, Longman Publishing.
5. V Ganesan: "*Gas Turbines*", 2002

Advanced Refrigeration

	Advanced Refrigeration	PEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Outcomes:

At the end of the course, student should be able to:

CO1	Study conventional and non-conventional refrigeration system
CO2	Formulate and solve vapor compression refrigeration and multi-stage vapor compression systems. Study and identify various types of refrigerants and their properties., such as zeotropic,
CO3	Different refrigeration system equipment study in detail
CO4	Study Cooling load calculation of refrigeration system
CO5	Refrigeration system conreoller and other instruments study

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Conventional Refrigeration Systems: Multi-evaporator system; Multi expansion system; Cascade systems; study of P-h; T-s; h-s and T- h charts for various refrigerants, Concept of Heat Pump

Non-conventional refrigeration system (Principle and thermodynamic analysis only): Thermoelectric refrigeration, thermo-acoustic refrigeration, adsorption refrigeration, Steam jet refrigeration, vortex tube refrigeration, and magnetic refrigeration.

Unit 2

Vapour absorption refrigeration: Standard cycle and actual cycle, thermodynamic analysis, Li-Br-water, NH3-water systems, Three fluid absorption systems, half effect, single effect, single-double effect, double effect, and triple effect system

Refrigerants: Refrigerant recycling, reclaim and charging, alternative refrigerants, refrigerant-lubricant mixture behavior, ODP, GWP concepts

Unit 3

Refrigaration Equipment's - Reciprocating, screw, Scroll and Centrifugal Compressor, Evaporator Design & Selection of evaporator **,** types of evaporator, thermal design, effect of lubricants

Condenser: Design and selection, types, thermal design, purging, selection and capacity control Selection of\expansion devices, Design of refrigerant piping, refrigeration system controls and safety devices, accumulation, draining of lubricants, selection and capacity control

Unit 4

Cooling load estimation Equipment selection and design: Component Balancing, Analysis of designed equipment (thermodynamic), cost analysis and feasibility analysis for designed equipments, tools and equipments used in refrigeration

Unit 5

Control & Instrumentation: Refrigeration system controller, high pressure receiver, Thermal design of low pressure receiver, accumulator, Filters, driers, oil separators, relief valves, safety valves, high and low pressure cut out, thermostats, water regulators System controller.

Recommended Books

1. R.J. Dossat, Principles of refrigeration, Pearson Education Asia
2. C.P. Arora, Refrigeration and Air-Conditioning
3. Stoecker and Jones, Refrigeration and Air-conditioning
4. Jordan and Priester, Refrigeration and Air-conditioning
5. A.R. Trott, Refrigeration and Air-conditioning, Butterworths
6. J.L. Threlkeld, Thermal Environmental Engineering, Prentice Hall
7. W.F. Stoecker, Industrial Refrigeration Handbook, McGraw-Hill
8. John A. Corinchock, Technician's guide to Refrigeration systems, McGraw-Hill
9. P.C. Koelet, Industrial Refrigeration: Principles, design and applications, b Mcmillan
10. ASHRAE Handbook (i) Fundamentals (ii) Refrigeration
11. ISHRAE handbooks
12. ARI Standards
13. Refrigeration Handbook, Wang, Mc Graw Hill, Int.
14. Refrigeration –Malhotra Prasad

Machine Learning and Applications

	Machine Learning and Applications	OE	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Objectives:

1. To master the concepts of supervised and unsupervised learning, recommendation engine, and time series modelling
2. To gain practical knowledge over principles, algorithms, and applications of Machine Learning through a hands-on approach and to validate Machine Learning models and decode various accuracy metrics.
Improve the final models using another set of optimization algorithms, which includeBoosting & Bagging techniques
3. To acquire thorough knowledge of the statistical and heuristic aspects of Machine Learning and To comprehend the theoretical concepts and how they relate to the practical aspects of Machine Learning.
4.To implement models such as support vector machines, kernel SVM, naive Bayes, decision tree classifier, random forest classifier, logistic regression, K-means clustering

Outcomes:

CO1	Understand machine learning techniques and computing environment that are suitable for the applications under consideration.
CO2	Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
CO3	Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications
CO4	Implement various ways of selecting suitable model parameters for different machine learning Techniques
CO5	Application in Machine learning

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

1. Foundations for Machine Learning [ML]: ML Techniques overview: Supervised; Unsupervised, Reinforcement Learning, Validation Techniques (Cross- Validations)**;**Feature Reduction/Dimensionality reduction; Principal components analysis (Eigen values, Eigen vectors, Orthogonality)

2. Clustering: Distance measures; Different clustering methods (Distance, Density, Hierarchical); Iterative distance-based clustering; Dealing with continuous, categorical values in K-Means; Constructing a hierarchical cluster; K-Medoids, k-Mode and density-based clustering; Measures of quality of clustering

3. Classification: Naïve Bayes Classifier Model Assumptions; Probability estimation; Required data processing; M-estimates;, Feature selection: Mutual information; Classifier
K-Nearest Neighbors: K-Nearest Neighbor algorithm; Aspects to consider while designing K-Nearest Neighbor Support Vector Machines;SVM for classification and regression problems.

4. Association Rule mining: The applications of Association Rule Mining: Market Basket, Recommendation Engines, etc. ; A mathematical model for association analysis; Large item sets; Association Rules; Apriori: Constructs large item sets with mini sup by iterations; Interestingness of discovered association rules; Application examples; Association analysis vs. classification ; FP-trees

5. Research Aspects: Application of ML in various domains-Research Paper Publication in Quality Indexed International Journals/ Conferences; Practical Implementation of Industry Projects/Applications**;** IPR

Text Books:
1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e.

Reference Books:
Ethem Alpaydin, Introduction to Machine Learning

Industrial Product Design

	Industrial Product Design	OE	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	Able to understand Traditional and modern design processes; Organization objectives
CO2	Will understand reverse engineering in product design
CO3	Different forms or formats to share the modelled product
CO4	In detail study of Concept of concurrent engineering;
CO5	Analyze the rapid prototyping method of product design

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2		1		1	1							
CO3			1	1		1						
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Product Design: Traditional and modern design processes; Organization objectives; Innovation, creation, and diffusion techniques; Evaluation of new product ideas – functional, technological, ecological, legal.

Unit 2

Product Modeling and Reverse Engineering: Wireframe modeling; Surface modeling – boundary representation; Solid modeling – CSG; Concept of reverse engineering.

Unit 3

Product Data Exchange: Neutral file formats for product data exchange–DXF, IGES, STEP.

Unit 4

Concurrent Engineering: Concept of concurrent engineering; Design for X; Design for manufacturability (DFM); Design for assimilability (DFA); Design for reliability (DFR); Design for quality (DFQ).

Unit 5

Rapid Prototyping Methods: Liquid based RP methods –stereolithography apparatus (SLA), solid ground curing (SGC), solid creation system (SCS), etc.; Solid based RP methods: Fused deposition modelling (FDM), laminated object manufacturing (LOM), etc.; Powder based RP methods– selective laser sintering (SLS), 3D printing (3DP), ballistic particle manufacturing (BPM), etc

References

- Andrearsen, M. M., and Hein, L., "Integrated Product Development", Springer, 1987

- Huang, G. Q., "Design for X: Concurrent Engineering Imperatives", Chapman and Hall, 1996
- Chitale, A. K. and Gutpa, R. C., "Product Design and Manufacturing", Prentice Hall, 1997
- ZeidI., "CAD/CAM: Theory and Practice", Tata McGraw Hill., 1998
- Mortenson, M. E., "Geometric Modeling", 3rd Ed., Industrial Press, 2006
- Boothroyd G., Dewhurst P., and Knight, "Product Design for Manufacture and Assembly", 2nd Ed., Marcel Dekker., 2002
- Chua, C. K and. Leong, K. F., "Rapid Prototyping: Principles and Applications in Manufacturing",John Wiley & Sons, 1997

Control Techniques in Electrical Drives

	Control Techniques in Electrical Drives	OE	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objective

1. To define electric drive, its parts, advantages and explain choice of electric drive.
2. To explain dynamics and modes of operation of electric drives.
3. To explain selection of motor power ratings and control of dc motor using rectifiers.
4. To analyze the performance of induction motor drives under different conditions.
5. To explain the control of induction motor, synchronous motor and stepper motor drives.
6. To discuss typical applications electrical drives in the industry

Course Outcomes:

At the end of the course, student should be able to:

CO1	1. Explain the advantages and choice of electric drive.
CO2	2. Explain dynamics and different modes of operation of electric drives.
CO3	3. Suggest a motor for a drive and control of dc motor using controlled rectifiers.
CO4	4. Analyze the performance of induction motor drives under different conditions.
CO5	5. Control induction motor, synchronous motor and stepper motor drives.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Selection of Motor Power Ratings: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **Direct Current Motor Drives:** Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor

Unit 2

Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of Induction Motor Fed from Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.

Unit 3

Control Technique for Induction Motor Drives

Voltage Source Inverter (VSI) Control, Cyclo-converter Control, Closed Loop Speed Control and Converter Rating for VSI and Cyclo-converter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control, speed control of single phase induction motors.

Unit 4

Synchronous Motor Drives: Operation from fixed frequency supply-starting, synchronous motor. Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives.

Unit 5

Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping Rate Characteristics, Drive Circuits for Stepper Motor.

Industrial Drives: Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.

Text Books:

1. Gopal K Dubey , Fundamentals of the electrical drives Narosa publication
2. N. Mohan T.M. udeland & W.P.Robbins , Power Electronics converter application J.Wiley & sons
3. Vedam Suryavanshi**,** Electrical Drives Concept and application
4. B.K. Bose, Advanced power Electronics & A.C. Drives

Solid Wate Management

	Solid Wate Management	OEC	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Outcomes:

At the end of the course, student should be able to:

CO1	Identify the different sources of solid wastes.
CO2	Execute the relevant method of collection and transportation of solid wastes.
CO3	Execute an action plan for disposal of solid wastes.
CO4	Implement the relevant method for disposal of Bio-medical wastes.
CO5	Implement the relevant method for disposal of Industrial wastes and E-waste.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Fundamentals of solid waste management

Definition of solid waste, Meaning of different solid waste - Domestic Waste, commercial waste, industrial waste, market waste, agricultural waste, biomedical waste, E-waste, hazardous waste, institutional waste, Sources of solid waste, Classification of solid waste - hazardous and non- hazardous waste., Physical and chemical characteristics of municipal solid waste.

Unit 2

Storage, Collection and Transportation of Municipal Solid Waste

Storage of solid waste, Collection methods of solid waste, Tools and Equipment-Litter Bin, Broom, Shovels, Handcarts, Mechanical road sweepers, Community bin - like movable and stationary bin Transportation of municipal waste.

Unit 3

Disposal of Municipal Solid Waste

Concept of composting of waste, Principles of composting process. Factors affecting the composting process, Methods of composting -, Manual Composting- Bangalore method, Indore Method, Mechanical Composting - Dano Process, Vermicomposting., Land filling technique, Factors to be considered for site selection,Land filling methods-Area method, Trench method and Ramp method., Leachate and its control, Biogas from landfill Advantages and disadvantages of landfill method, Recycling of municipal solid waste

Unit 4

Biomedical Waste management a& Health aspects and public Involvement in Solid Waste Management

Definition of Bio medical Waste., Sources and generation of Biomedical Waste, Classification of Biomedical Waste., Management technologies.

Health aspects and public Involvement in solid waste management, Health aspects during handling and process, Health problems during time of segregation, recovery, recycling and reuse of solid waste. Public involvement and participation in solid waste management practices.

Unit 5

Industrial Waste management and E-waste waste management

Variety of industrial waste, Collection and disposal of industrial waste,, Control measures for industrial waste, Recycling of industrial waste.

E-waste Management

Definition of E- waste, Varieties of E- wastes, Dangers of E- waste, Recycling of E- waste Disposal of E- waste.

Mechatronics & Embedded System

	Mechatronics	OE	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objective

(i) implementing electronics control in a mechanical system

(ii) enhancing existing mechanical design with intelligent control and

(iii) replacing mechanical component with an electronic solution.

Course Outcomes:

At the end of the course, student should be able to:

CO1	Explain Mechatronics System.

CO2	Analyze the Mechatr·onics Based System.
CO3	Model, simulate, and verify the mechatronics systems.
CO4	Use and apply available automotive sensors and actuators in various electronic control systems while designing automotive system design.
CO5	Apply knowledge of modern technologies in automotive design.

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

Unit 1

Introduction:

What is Mechatronics, Integrated Design Issues mechatronics, Mechatronics Design Process, Mechatronics Key elements, applications in mechatronics.

Unit 2

Modelling and Analysis of Mechatronics Systems:

Block Diagram Modelling, Analogy approach, Impedance Diagrams, Elecnical Systems, Mechanical systems and_ electromechanical systems. Mass-Spring-Oscillation and Damping system, Dynamic response of systems, Transfer function and frequency response. Labview, MATLAB, Scilab.

Unit 3

Sensors and Actuators:

Performance tenninology of sensors, Displacement, Position & Proximity Sensors, Displacement, Position sensors, Force, Fluid pressure, Liquid flow sensors, temperature, light sensor, Acceleration and Vibration measurement,
Electrical and Mechanical Actuation Systems.

Unit 4

Signal Conditioning:

Introduction to signal processing, Op-Amp as signal conditioner, Analogue to Digital Converter,

Digital to Analogue Converter, Signal processing devices, relays, contactors and timers. Microcontrollers, PID controllers and
PLCs

Unit 5

Active and passive safety systems:

Body electronics including lighting control, Remote keyless entry, Immobilizers etc., Electronic instrument clusters and dashboard electronics, Antilock braking system, Electronic stability program, Air bags, Computer vision based ADAS

References:

Text Books:

1. Bradley, D. Dawson, N. C. Burd and A.J. Loader, "Mechatronics: Electronics in product and process", Chapman and Hall, London.
2. Devadas Shetty, Richru·d A. Kolkm, "Mechah·onics system design, PWS publishing company.
3. David G. Alciatore, Michael B. Histand, "Introduction to mechatronics and measurement systems" Mc Graw Hill Education.

References Books:

1. Intelligent Mechatronic Systems: Modeling, Control and Diagnosis, R. Merzouki, K. Samantaray, P. M. Pathak, B. Ould Bouamama, Springer, London.

Environmental Engineering

	Environmental Engineering	OE	3-0-0	3 Credits
Exam Scheme				
Mid Sem Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Objectives:

After Completing this course, student will have adequate background to understand and solve the problem involving:

1. To learn about Global warming and its effect
2. To demonstrate knowledge in the reduction of global warming.
3. To learn the control measures of carbon emission and accumulation.
4. To learn high tech measures for Reducing Carbon Emissions.

Outcomes: After Completing this course, students are able to

CO1	Study the effects of Global warming
CO2	Implement the concept of reduction of global warming
CO3	Understand the remedial action for the carbon emission and accumulation.

CO4	Apply high tech measures for Reducing Carbon Emissions.
CO5	Study High-tech Measures for Reducing Carbon Emissions

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2		1		1	1							
CO3			1	1		1						
CO4												
CO5												

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Content

1. Global Warming and its effect:- Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India,
Planning for the Future to reduce global warming:- Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People

2. Opportunities in Control of Carbon Emissions and Accumulation:- Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India**.**

3. Green Technologies for Energy Production:- Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.
Green Technologies for Personal and Citywide Application :- Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports.

4 Green Technologies for Specific Applications:- Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC), Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbors, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects

,'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.

5 Some High-tech Measures for Reducing Carbon Emissions :- Use of Solar Power with Satellite-Based Systems ,Use of Carbon Capture and Storage (Sequestration) ,Microorganisms, A Quick SWOT Analysis. **Recommended Plan of Action :-** India' National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, Few case studies on Projects undertaken by Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change

Text Books:

1. Green Technologies, Soli J. Arceivala, Mc Graw Hill Education.
2. Green Technologies and Environmental Sustainability edited by Ritu Singh, Sanjeev Kumar

Semester-III

Dissertation Phase-I

	Dissertation Phase-I	**PCC**		**10 Credits**
Exam Scheme				
Continuous Assessment 200 Marks		End Sem PR/OR Exam 100 Marks		Total 300 Marks

Course Outcomes: At the end of the course, student will be able to

CO1	Identify problems and to plan methodologies to solve problems.
CO2	Carry out exhaustive literature review, study &evaluate collected literature critically and identify the gaps based on the review.
CO3	Select the specific problem for the study as a project
CO4	Demonstrate technical writing while preparing project report and present it to evaluation committee to demonstrate presentation skills acquired

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Mapping of Cos with Pos

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**								**1**			**1**
CO2		**3**								**2**		**1**
CO3		**2**					**1**	**1**		**2**	**2**	**2**
CO4	**2**								**1**			

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

Course Contents:

Project (stage-I and II) should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.

The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator/Faculty Advisor. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

English for Research Paper Writing

	English for Research Paper Writing	AC	0-0-0	No Credits
Exam Scheme				
	Continuous Assessment 50 Marks			Total 50 Marks

Objectives:

After Completing this course, students are able

Outcomes:

CO1	
CO2	
CO3	
CO4	
CO5	

Mapping of Cos with Pos:

Pos → Cos↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution

Course Content

UNIT 1: FOUNDATIONS OF ACADEMIC ENGLISH IN RESEARCH

Academic English – MAP (Message-Audience-Purpose) – Language Proficiency for Writing – Key Language Aspects – Clarity and Precision – Objectivity – Formal Tone – Integrating References – Following Academic Conventions

EFFECTIVE WRITING STYLE FOR RESEARCH PAPERS

Word Order – Sentences and Paragraphs – Link Words for Cohesion – Avoiding Redundancy / Repetition – Breaking up long sentences – Structuring Paragraphs – Paraphrasing Skills – Framing Title and Sub-headings

UNIT 2: ADVANCED READING SKILLS FOR RESEARCHERS

Reading Academic Texts – Critical Reading Strategies – Skimming and Scanning – Primary Research Article vs. Review Article – Reading an Abstract – Analysing Research Articles – Identifying Arguments – Classifying Methodologies – Evaluating Findings – Making Notes

RESEARCH VOCABULARY DEVELOPMENT

Formulaic Expressions – Synonyms and Nuances – Academic Phrase Bank – Discipline-Specific Vocabulary – Formal Expressions and Idioms – Language for Describing Results – Commonly Misused Words – Effective Use of Adjectives and Adverbs

UNIT 3: GRAMMAR REFINEMENT FOR RESEARCH WRITING

Advanced Punctuation Usage – Grammar for Clarity – Complex Sentence Structures – Active- Passive Voice – Subject-Verb Agreement – Proper Use of Modifiers – Avoiding Ambiguous Pronoun References – Verb Tense Consistency – Conditional Sentences

MASTERY IN REVISING, EDITING, AND PROOFREADING

Effective Revisions – Restructuring Paragraph – Editing vs Proofreading Editing for Clarity and Coherence – Rectifying Sentence Structure Issues – Proofreading for Grammatical Precision – Spellings – Tips for Correspondence with Editors

UNIT 4: PRESENTATION LANGUAGE SKILLS

Written vs. Spoken English – Dynamic Vocabulary for Presentations –Expressive Language for Audience Engagement – Q&A Session Preparation Strategies – Language for Clear and Impactful Slides – Adapting Language Style to Different Audiences

UNIT 5: TECHNOLOGY AND LANGUAGE FOR RESEARCH

Digital Literacy and Critical Evaluation of Online Content – Technology and Role of AI in Research Writing – Assistance in Generating Citations and References – Plagiarism and Ethical Considerations – Tools and Awareness – Fair Practices

Books and references

1. Bailey. S. 2015. Academic Writing: A Handbook for International Students. London and New York: Routledge.
2. Craswell, G. 2004. Writing for Academic Success. Sage Publications. Crème, P. & M. Lea. 2008.
3. Writing at University: A guide for students. Open University Press. Oshima, A. & Hogue, A. 2005.
4. Writing Academic English, Addison-Wesley, New York Swales, J. & C. Feak. 2012.
5. Academic Writing for Graduate Students: Essential Skills and Tasks. Michigan University Press. Wallwork, Adrian. 2015.
4. English for Academic Research: Grammar, Usage and Style,Springer, New York---2011.
5. English for Writing Research Papers, Springer, New York

Semester-IV

Dissertation Phase-II

	Dissertation Phase-II	**PCC**	**0-0-0**	**20 Credits**
Exam Scheme				
Continuous Assessment 200 Marks		End Sem PR/OR Exam 100 Marks		Total 300 Marks

Course Outcomes: At the end of the course, student will be able to

CO1	Solve identified technical problem using acquired knowledge and skill.
CO2	Use latest equipment, instruments, software tools, infrastructure and learning resources available to solve the identified project problem. Procure resources, if required.
CO3	Interpret theoretical/experimental findings using available tools
CO4	Compare the results obtained with results of similar studies
CO5	Draw conclusions based on the results

Mapping of COs with POs:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**								**1**			**1**
CO2		**3**								**2**		**1**
CO3		**2**					**1**	**1**		**2**	**2**	**2**
CO4	**2**								**1**			
CO%		**1**						**1**				**2**

Course Contents/Objective

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format as provided by the department/guide.

The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.

The report must bring out the conclusions of the work and future scope for the study. The work has to be presented before the panel of examiners consisting of an approved external examiner, internal examiner/guide as decided by the Head and PG coordinator/Faculty Advisor. The candidate has to be in regular contact with his guide throughout the project duration

Disaster Management

	Mini Project		PCC	0-0-0	No Credits
Exam Scheme					
CA 25 Marks		CA 25 Marks		PR/OR Marks	Total 50 Marks

Course Outcomes:

At the end of the course, student should be able to:

CO1	To provide basic conceptual understanding of disasters
CO2	To understand approaches of Disaster Management
CO3	To build skills to respond to disaster

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												

Note: 1- Means least contribution 2- Means medium contribution 3- Maximum contribution Course

Contents:

Unit: I Definition and types of disaster

Hazards and Disasters, Risk and Vulnerability in Disasters, Natural and Man-made disasters, earthquakes, floods drought, landside, land subsidence, cyclones, volcanoes, tsunami, avalanches, global climate extremes. Man-made disasters: Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

Unit: II Study of Important disasters

Earthquakes and its types, magnitude and intensity, seismic zones of India, major fault systems of India plate, flood types and its management, drought types and its management, landside and its managements case studies of disasters in Sikkim (e.g) Earthquakes, Landside). Social Economics and Environmental impact of disasters.

Unit: III Mitigation and Management techniques of Disaster

Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warming Systems, Building design and construction in highly seismic zones, retrofitting of buildings.

Unit IV Training, awareness program and project on disaster management

Training and drills for disaster preparedness, Awareness generation program, Usages of GIS and Remote sensing techniques in disaster management, Mini project on disaster risk assessment and preparedness for disasters with reference to disasters in Sikkim and its surrounding areas.

Text Books:

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)

2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.

3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.

4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.

5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD

a Mission, 2003